SEVENTH ANNUAL REPORT

OF THE

Geological Survey

OF

INDIANA,

MADE DURING THE YEAR 1875,

BY

E. T. COX,

STATE GEOLOGIST;

ASSISTED BY

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DR. G. M. LEVETTE.

INDIANAPOLIS:
SENTINEL COMPANY, PRINTERS.
1876.

OFFICE OF STATE GEOLOGIST,

INDIANAPOLIS, INDIANA,

December 30th, 1875.

To the Hon. President, and Members of the

Indiana State Board of Agriculture.

GENTLEMEN:—I herewith submit to your honorable body my Seventh Annual Report of progress in the Geological Survey of the State, embracing detailed reports on the counties of Ripley, Jennings, Orange, Vanderburg, Owen, Vigo, Montgomery and Huntington, and partial reports on Clay and Putnam counties; which, together with other important and interesting information, will be found in the body of the Report.

Very Respectfully,

E. T. COX,

State Geologist.

PREFACE.

In consequence of the small sum of money appropriated for the State printing, it has been found impossible to publish more than a part of the county geological maps and the numerous horizontal sections that have been prepared to show the continuity of the seams of coal and associated beds of shales, sandstones and limestones. These sections are of great importance to present the geology in a clear and comprehensive manner. It is hoped, therefore, that the Legislature will make a special and adequate appropriation to enable the Geologist hereafter, not only to publish what maps and sections are needed to make comprehensive the dynamical geology of the various counties, but also to cover the necessary expenses of engraving and publishing plates containing figures of the characteristic fossils of the various geological formations as this will render the report more useful to students in the universities, colleges and high schools of Indiana.

GEOLOGICAL REPORT.

During the present year, 1875, Prof. John Collett has made a survey of Vanderburg, Owen and Montgomery counties. He has, also, visited a portion of Clay and Putnam counties, where, especially in the former, new and valuable mining industries have sprung up since the publication of the first report. Prof. W. W. Borden has made a survey of Jennings and Ripley counties.

Dr. G. M. Levette, assisted by Mr. Caleb Cooke, of the Peabody Academy of Science, Salem, Mass., made surveys of a number of lakes situated in the counties of Fulton, Laporte, Kosciusko, Noble and Steuben. This survey embraced a study of the character of the strata and deposits surrounding the lakes, the depth of water and its temperature at different depths, collections of the fishes and mollusks, and samples of the dredgings of ooze or mud, from the deepest water, for microscopic examination.

The very large and interesting collection of fishes made by this survey, among which it is believed a number of new species will be found, has been placed in the hands of Prof. F. W. Putnam, of Peabody Academy, Salem, Mass., for the purpose of having them described and properly named. It is feared, however, that owing to unforseen business relations, Prof. Putnam will not be able to furnish his report on them in time for publication in this volume.

Dr. Moses N. Elrod, of Orleans, and Dr. E. S. McIntire, of Mitchell, Ind., have jointly furnished a report on Orange county. Dr. J. Schneck, of Mt. Carmel, Ill., has very

obligingly furnished a catalogue of the flora and sylvia of the Wabash valley below the mouth of White river.

This report is accompanied with highly valuable notes which give, among other things, the measurements made of the diameter and hight attained by many of the noble forest trees of that fertile region. The sections furnished by Elrod and McIntire, of the rocks in Orange county, represent the St. Louis limestone as the lowest, and the millstone grit as the highest palæozoic rocks in the county, and the glacial drift as immediately succeeding the latter.

The millstone grit may be traced from Lawrence and Martin counties into Orange county, and is everywhere recognized by being full of quartz pebbles. Though the upper part is a massive conglomerate, the lower beds are in thin layers and sometimes schistose or shaly. While it generally rests upon the upper Chester Archimedes limestone in Lawrence county, there is an intervening bed of workable coal near Shoals, in Martin county; also near Bloomfield, in Greene county, and at many other localities in this part of the coal field. In Spice Valley township, Lawrence county, the Archimedes limestone has locally been removed by chemical action, and its place is occupied by a valuable bed of porcelain clay, "Indianaite"* and hydrated brown-oxide of iron.

A marked variation in the thickness as well as in the mineral character of the rocks representing a geological epoch is not confined to the millstone grit series, but is to be met with in all formations of sedimentary origin.

The millstone grit of Orange county possesses unusual interest because it furnishes the whetstones and grindstones that have a world-wide reputation under the name of "Hindostan" or "French Lick" stones. They received the name of Hindostan stones from the village of Hindostan, which was situated on the bank of East White river, twelve or fifteen miles west of the quarries, and thus became the port from which the stones were shipped down

*See description in Geol. Rep. for 1874, p. 15.

the river to market. But this village, which was once the county seat of Martin county, has long since been deserted and only one log cabin remained to mark its site when I visited the spot in 1870, and the Hindostan stones, though still retaining the name, find their way to the markets of the world through other channels of trade. It may seem strange, but experience has proved that for sharpening special kinds of mechanical tools the whetstones from Orange county are superior to any other known grits, and they are largely shipped to England. It is not from their commercial importance alone that these grit beds are of special interest to the geologist, but they are abundantly filled with the fossil remains of a magnificent flora. Dr. Elrod has made a fine collection of these plants and they have been identified by Prof. Leo Lesquereux as representatives of the carboniferous flora and he gives the names as follows:

Sphenopteris latifolia, Brg't.
Sphenopteris tridactylites, Brg't.
Neuropteris Smithii, Lesq.
Neuropteris Elrodi, *sp. nov.*, closely allied to the former.
Lepidodendron obovatum, Sternb.
Lepidodendron Valtheimianum, Sternb.
Lepidodendron dichotomum, Sternb.
Lepidophlorus, new species?

I enclosed the following section made by Elrod and McIntire to Prof. Lesquereux and he assures me that I have correctly designated the whetstone beds as belonging to the Conglomerate or Millstone grit.

Section at Dishman's quarry.

	ft. in.
Conglomerate with pebbles	45.00
Siliceous iron ore	5.00
Massive sandstone, buff, fine grained, filled with Stigmaria roots which render it unfit for whetstones or other uses	20.00
Shaley sandstone, bluish color	4.00
Whetstone in 2½ feet layers with shale between, filled with ferns, lepidodendrons, etc., 15 feet of good grit	20.00

	ft. in.
Black bituminous shale	.4
Coal, good quality	.10
Under clay	.6
Shaly sandstone	3.00
Massive sandstone, locally white, glass sand	35.00
Upper Chester limestone *Archimedes Wortheni*, *Pentremites robustus*, *P. pyriformis*, *Athyris subtilita* and *Bryozoans*	3.00
Covered and massive sandstone, grindstone grit, *Stigmaria*, *Lepidodendrons*, *Siqiliaria*, but no ferns have yet been found	70.00
Chester limestone (middle member) same fossils as above	12.00
Sandstone alternating with shale, locally good flagging, *stigmaria* and *sigillaria*, middle contains coal 4 inches	25.00
Lower Chester limestone, lithographic, same fossils as above 60 to	90.00
St. Louis limestone, chert, with *lithostrotian*	2.00
Magnesian limestone, fire stone, lower part concretionary and filled with same fossils as above	50.00
Argillaceous limestone	40.00
Bituminous oil limestone, coal 2 in	10.00
	435.8

This section, with the exception of the lower part, is seen at F. E. Dishman's quarry, S. 24, T. 3 N., R. 1 W.

The coal, 10 inches thick, is seen in many places in the western part of Orange county as well as in the southeastern part of Martin county, and I believe it to be the equivalent of the sub-conglomerate coal near Shoals in the latter county.

Since it has been assumed by western geologists that the upper Archimedes limestone marks the upper limits of the Chester group, we have in this formation a good guide for establishing the horizon between the upper and lower carboniferous epochs. While the stems and trunks of *Lepidodendron*, *Sigillaria* and *Stigmaria* are found abundant in the Chester sandstone immediately under the upper limestone, they have thus far furnished no remains of filices.

The above reports will be found in their proper places.

In addition to the general management of the survey and increasing duties of the office, I have been able to make a

survey of Vigo and Huntington counties. In the office and laboratory work I have been assisted by Dr. G. M. Levette, and a large number of analyses of coals, limestone, iron ores, hydraulic cements and mineral waters have been made.

ANALYSES OF COALS.

Notwithstanding the attention which chemists have given to the analysis of mineral coals, it appears that there is yet much to learn in regard to the nature of the substances formed by its elementary constituents and to the changes which these substances undergo when under the influence of heat and pressure, or the atmosphere at common temperatures. Without discussing in this place the relative merits of proximate and elementary analyses for determining the industrial value of coal, I will proceed to recount the nature of the investigations which have been made in the laboratory during the year for ascertaining the character and calorific intensity of the Indiana coals.

There are almost endless varieties of mineral coals. They differ from one another, not only physically, but in their manner of burning, in the molecular arrangement of their elementary constituents, and in their heat-producing powers. They differ in every coal basin, and in parts of the same field and same seam. We may classify them into anthracite and bituminous coals, and a few other well marked types, yet there are shades of difference which gradually blend them together, so that, as a general rule, the coals at each mine will require a specific study, for they have a distinct industrial value. Coal I, which is usually a non-caking or block coal in the eastern part of the Indiana coal basin, passes into a caking coal a few miles west of Brazil, in Clay county; to the south, at Cannelsburg, Daviess county, the upper part of a correlated seam has four feet of dull-black, close-textured, ringing cannel coal, which gives 5.2 cubic feet of 25 candle gas to the pound.

The cannel coal is firmly united at the base to two feet of glistening, jet-black, caking coal.

Fossil fuel is usually classified as Anthracite, Bituminous, Lignite or Brown Coal, and Peat. Anthracite is a hard coal, black, sub-metallic, sometimes iridescent (peacock colors), and brilliant, fracture usually conchoidal. It yields 85 per cent. of fixed carbon, and after drying, from 3 to 6 per cent. of volatile matter, burns with feeble flame of pale color. Anthracite graduates into bituminous coal, consequently we have semi-anthracite and semi-bituminous, as the fixed carbon approximates nearest to one or the other. Anthracite is not found in the coal measures west of the Appalachians. In 1864 Prof. Richard Owen and myself examined a seam, from four and a half to five feet thick, of good anthracite, iu the Placer Mountains, twenty-seven miles south of Santa Fee, in New Mexico. It was overlaid by a mass of porphyry, and is probably of cretaceous age. For the sake of comparison, I subjoin the proximate analysis which I made of this coal:

Carbon	87.00	per cent.
Ash, red	5.00	"
Gas	4.50	"
Water	3.50	"

In the Jennie Lind Prairie, near Fort Smith, Arkansas, there is a seam, four to five feet thick, of semi-anthracite coal, which belongs to the lower part of the coal measures. It is covered by a few feet of shale and soil, and has to be worked by stripping. A proximate analysis of the top and bottom gave:

	Top.	Bottom.
Fixed carbon	82.25	84.10
Volatile matter	12.35	10.70
Ash, light brown	4.00	1.40
Water	1.40	3.80

Closely allied to anthracite is a native coke, found near Richmond, Va.; it is more compact than artificial coke, but contains some bitumen.

All the coals of the Indiana field belong to the class

known as bituminous. The principal varieties may be designated as follows:

Caking coal, long flame, gas and smith coal, fat coal.

Semi-caking coal, long flame.

Block coal, non-caking coal, long flame, dry burning coal, furnace coal.

Semi-block coal, long flame.

Cannel coal, long bright flame, dry burning, gas coal.

Lignite, or brown coal, is not found in Indiana. It differs from the bituminous coals in containing a large per cent. of hygrometric water and oxygen. It burns with considerable flame, without melting or changing form.

Peat is a fossil fuel which is forming, even at the present time, and furnishes striking evidence of the mode of origin of the older beds of coal. It is found in many of the counties in the north part of the State, and will eventually prove of great commercial value to the people of that region, though the present low price of coal, and its great abundance, has thus far caused it to be neglected as fuel. At some of the railway crossings of the Kankakee marsh, peat beds have been probed to the depth of 50 feet.

The following constitute the most marked varieties of bituminous coal:

Caking coal; non-caking or block coal; semi-caking, or semi-block coal; and cannel coal.

The seams of caking coal in Indiana are, locally, not less than fifteen in number, and they vary from a few inches to seven and eight feet in thickness. There are as many as three seams, found over a great portion of the field, that have a united thicknesss of 15 to 20 feet.

Caking coal varies in color, being black, brownish-black, brilliant-black, and iridescent, (peacock coal). Its fracture is cubical, conchoidal, splinty and obsolete laminæ often appear in its structure.

Most of the bituminous coals of America, England, France and Germany are of this variety. They soften and become pasty, or semi-viscid in the fire at a moderate temperature, and give off a large amount of inflammable gas. When,

by the prolonged action of heat, all the volatile matter has been driven off, there will remain a grayish black cellular mass called coke. The amount of coke left, or carbon not volatile, varies from 45 to 80 per cent. On account of its melting and running into a mass under the influence of fire, this kind of coal can not be used in its natural state to smelt iron ores, as it would form into a cake and stop the passage of the blast, but when previously charred or converted into coke, the latter constitutes one of the best fuels for the reduction of ores known to the world. The manufacture of coke, however, requires an additional expenditure of labor and involves a loss of at least one-third of the productive heat of the coal.

Block Coal.—In these coals the volatile matter holds about the same relation to the fixed carbon as in the caking coals, but its quality is such that the usual heat produced by burning is not sufficient to render the coal viscid or produce caking, and when the volatile matter is expelled there remains a charred mass of hard, close-textured coke that resembles the original coal in shape and structure; in other words, the coke does not swell and puff up, but retains the laminated structure of the coal. The block coal of Indiana is, therefore, a non-caking, bituminous coal. It has a laminated structure, and contains between the laminæ a soft black substance, that in its fibrous-like structure greatly resembles charcoal. Its composition by proximate analysis is

Carbon	63.00 per cent.
Gas	32.50 per cent.
Ash, white	1.00 per cent.
Water	3.50 per cent.

An ultimate analysis of the same gave:

Carbon	.8270
Oxygen	.0881
Hydrogen	.0477
Nitrogen	.0174
Sulphur	.0098
Ash	.0100

Block coal may be readily split into sheets or thin slabs in the direction of its bedding lines, but is very difficult to break in the opposite direction. The color is dull-black on the face and glistening or resinous black on the fractured edges. The beds are crossed at right angles, or nearly so, by lines of fracture that appear co-extensive with the field. These fractures also extend from top to bottom of the seam in such a manner that the coal may be readily taken out in great blocks, which gives rise to its name. This severing into blocks, the entire thickness of the seam, leaves the face of the mine notched and not smooth as is usually the case in mines of caking coal. The blocks are very compact and will endure rough handling and stocking without suffering material loss from abrasion. This, in a commercial point of view, gives the block coal great value over and above its other good qualities as a fuel for smelting iron and generating steam.

Cannel coal differs from the other varieties of bituminous coals in its physical appearance as well as in the manner of its burning. It has a more homogeneous structure, rings under the hammer, conchoidal fracture in every direction and does not crock and like the former coal, is usually mined in large blocks. The cannel coal of Daviess county is so hard and enduring that it has been used as a foundation for the engine and mine houses.

Cannel coal kindles readily and burns with a long, bright flame which illuminates the room and does not become viscid. The name is derived from the corruption of the word candle.

It is now universally admitted by all well informed people, that coal is derived from vegetable matter and is the fossil remains of land and water plants such as trees, reeds, ferns and mosses. The change from woody fibre to stone coal having been brought about by chemical action, a species of slow distillation, so to speak, whereby the oxygen, hydrogen and a portion of the carbon of the wood is eliminated in the form of water, carbonic acid and carburetted hydrogen. All the numerous varieties of fossil

fuel including asphalts, petroleum, lignites and peat are mainly, if not solely, due to the modified conditions under which this chemical change takes place, such as presence of water, greater or less pressure and heat.

On account of its homogeneous, compact structure some eminent geologists and fossil botanists have been led to conclude that cannel coal is formed from water plants which have a cellular structure, and not from fibrous land plants. While this theory may be true in some degree, it is not sustained by all the facts that may be brought to bear on the subject. The Breckenridge, Kentucky, Cannel coal, which is extremely rich in carbon oils and of a remarkable dense structure, appears to be made up entirely of Stigmaria stems and leaves and Lepidodendron. One seldom splits a block of this cannel coal without finding in it marks of Stigmaria or Lepidodendron well defined by a coating of pyrites. The wash-coal at the bottom of this seam contains Lepidodendron, Calamites and Stigmaria. The roof is formed of a heavy bed of black bituminous shale, containing fragments of ferns and *Lingula umbonata.* I accompanied Prof. Leo Lesqueureux on a visit to the Breckinridge coal in 1857 and his observations on its flora are given in 3d Vol. Ky. Rep., p. 532.

Here then we find one of the best oil producing cannel coals in the country, actually made up of the remains of air breathing plants. But since the roof shales contain the remains of marine brachiopods there is evidence that salt water was close at hand and may have had something to do in forming the character of the coal. Breckenridge cannel coal, according to Dr. Peters' analysis contains:

Moisture	1.30
Volatile matter	54.40
Carbon	32.00
Ash	12.30

The elementary analysis gave:

Carbon	68.128
Hydrogen	6.489
Nitrogen	2.274
Oxygen and loss	5.833
Sulphur	2.476
Ash	14.800

The Daviess county, Indiana, cannel coal, as already stated, is four feet thick and at the base is firmly cemented to a bed of brilliant black caking coal totally unlike the former in chemical composition. No plants have yet been seen associated with either part of the seams yet it is difficult to conceive that the vegetation should have suddenly changed from land to aquatic plants.

This is the most remarkable seam of coal of which I have any knowledge, and when taken in connection with the Breckenridge coal, sets at defiance the theory that cannel coal is due to a flora distinct from that which, in general, furnished anthracite and bituminous coals.

The Indiana cannel, like the Breckenridge, is rich in carbon oils and gas. It cotains from 7 to 10½ per cent. of very white ash and is remarkably free from pyrites. The quantity of ash greatly exceeds what we find in the caking and block coals of Indiana, though less than is found in the Breckenridge coal. In every case the ash is in excess of what could be derived from any species of plants known to botanists and in a great measure must have been furnished by water, either turbid or holding in solution minneral matter. If by the latter, as I suspect, then its presence must have had a marked influence in determining the character of the chemical change from wood to coal. If all cannel coals were alike burdened with a large excess of ash we might look to the mineral matter as a prime agent in its production, but while most cannels are in this category with regard to ash, there are some that contain very little. It would appear, therefore, that, so far, scientists have not been able to prove, in a satisfactory manner, that different varieties of coal are in any manner due to distinct species of plants.

In the Geological Report of Indiana, 1873, the results are given of experiments made, by Dr. Levette and myself, to show the effect produced on the fixed carbon of coal when charred under a pressure made by forcing the volatile matter to escape under a column of mercury from 0 to 12 inches high. Since then we have devised an apparatus with a pressure guage attached which indicates the exact pressure, in pounds, under which the gases are confined. With this apparatus we are enabled to distil coals, in 20 gram charges, under a pressure of one atmosphere or 15 pounds per square inch, without leak or danger to the iron retort. A stop-cock was placed in the half inch iron tube which forms the neck of the retort so that the coke may be cooled before coming in contact with the atmosphere.

The most important facts at present deduced from these experiments of coking under pressure are, an increase of fixed carbon obtained from some coals and an increasing tendency to fusibility or viscidity of the fixed carbon so obtained. This is particularly marked in the caking coals of Indiana, but most of all in those of Pennsylvania, such as the Connellsville coal, so celebrated for its dense, crystalline, silvery coke when the volatile matter is expelled in the ordinary coke-oven. And Stone's 2d pool, gas coal which is alike celebrated for its coke, but more especially as a gas coal. The latter coal yields 10,000 cubic feet of gas from a ton of 2,000 pounds, which has an illuminating power of 17 to 18 candles and at the Gas Works at Indianapolis, gives 61.25 per cent. of coke that is dense and crystalline in structure. For the sake of easy reference the results, published in the report for 1873, are here reproduced in table No. 1. The results obtained in 1875 are given in table No. 2, page 18.

TABLE NO. I.

NAME OF MINE OR OWNER.	Platinum crucible. Proximate analysis.	Iron retort. No mercury.	Iron retort. 3 inches mercury.	Iron retort. 6 inches mercury.	Iron retort. 12 inches mercury.
H. K. Wilson, Sullivan Co., Ind..	52.40	59.10	62.00	62.80	59.40
Simonson's, Knox Co., Ind.........	52.50	54.35	54.00	54.30	56.50
Shepard & Haslett's, Knox Co. Ind	55.50	56.10	56.40	57.95	56.15
Woodruff & Fletcher, Clay Co. Ind	57.50	58.85	60.40	58.50	59.25
Barnett's, Clay Co., Ind..............	58.50	62.20	61.75	62.60	63.40
Stone's, Pittsburg, Pa...	57.90	65.05	65.00	65.10	66.10

After recommencing the experiments of testing the effect of coking coals under pressure with the new and more complete apparatus, we soon found that, in order to obtain results strictly comparable with one another, fresh samples of coal should be had from the mines, embracing caking coal, block coal, and cannel coal, and then to begin the investigations at the very start and carry the pressure from 0 to 15 pounds, or more, to the square inch; for the protean hydrocarbon constituents of coal undergo a rapid change, whether exposed to the weather or kept in the house for even a short time.

In the first column of the above table will be found the proximate analyses made in the usual way, that is by charring one gram of the coal in a covered platinum crucible at a bright red heat. The sample of Connellsville coal analysed was sent by my esteemed friend, E. C. Pechin, of Dunbar Furnace, Fayette county, Pa. It is in large lumps, of quadrangular columnar structure, iridescent colors, and slightly coherent. The samples were several months on the road, and then remained some weeks in the laboratory before they were analysed, so we may consider it well seasoned coal. The gain under 15 pounds pressure amounts to 4 per cent. of fixed carbon.

Stone's gas coal, pool No. 2, gave 8.25 per cent. more fixed carbon under 15 pounds pressure than by proximate

TABLE NO. II.

Tabulated exhibit of Coals coked, in 20 gram charges, in iron-retort, with safety valve and pressure guage attached.

	Coke from proximate analysis.	Coked without pressure.	Coked at 15 pounds pressure.
Coal from Connellsville, Fayette County, Pennsylvania	71.50	74.50	75.50
Gas Coal, Stone's Pool No. 2, Alleghany County, Pennsylvania	48.50	69.50	70.50
Coal from Arbuckle & Budd, Seelyville, Vigo County, Indiana	53.50	61.20	61.20
Coal from Barnett's Mine, Clay County, Indiana—6 years old	58.50	62.50	63.00
Coal from Niblock's Mine, Clay County, Indiana	52 50	57.00	59.00
Coal from Carbon Block Coal Co., Clay County, Indiana—5 years old	56.75	61.20	66.50
Cannel Coal, Daviess County, Indiana—3 years old	50.50	57.00	57.50
Cannel Coal, Daviess County, Indiana—fresh specimen	48.50	48.50	49.10

analysis. The sample was obtained from the Indianapolis Gas Works, and had been on hand for a considerable but unknown length of time.

Arbuckle & Budd's coal had been in the laboratory about four weeks. It is a bright black, cubical, caking coal. The increase of fixed carbon, made under a pressure of 15 pounds, is 7.70 per cent.

Barnett's coal from Clay county is one of the most complete non-caking coals in the State. The sample analyzed had been on hand six years. By proximate analysis the particles were not nearly so firmly cemented together in coking as those subjected to pressure. It does not swell or puff up and the pieces that are put in the retort adhere together on account of a slight fusing of the edges which serves as a kind of solder.

Niblock & Zimmerman's northern mine is a block coal that contains a few thin layers of caking coal, from one-sixteenth to one-eighth of an inch thick, at intervals in the seam. The sample analyzed was obtained from the office of Niblock, Merrifield & Co., Indianapolis, and had been only a few days out of the mine. It contained 6 per cent. of hygroscopic water. The increase of fixed carbon under 15 pounds pressure amounted to 6.50 per cent. The coke was well cemented together and is good and strong.

Carbon Block Coal Co.'s block coal. This sample had been in the office five years.

The sample of cannel coal, three years old, gained under pressure 7 per cent. of fixed carbon, while the fresh specimen only gained 6 per cent. In these samples the structure of the coal remained unaltered. From the tables it will be seen that though there is a pretty uniform increase in the amount of fixed carbon when the coals are distilled under pressure, each seam of coal furnishes specific differences with reference to the effects of pressure on the fixed carbon. Coals from different seams are also differently affected by exposure for a long time to the influence of the air.

A fresh sample of caking coal taken from Dick's mine in Sullivan county and analyzed in 1870, gave:

Fixed carbon	50.50
Volatile, combustible matter	43.50
Water	4.50
Ash, brown	1.50

The same specimen exposed for six years on a shelf, in a room adjoining the laboratory, gave:

Fixed carbon	55.00
Volatile, combustible matter	40.00
Water	3.50
Ash, brown	1.50

By keeping this coal in the office for six years it has had the effect to change the specific gravity to the extent that a cubic foot has lost 1.19 per cent. of its weight. It has also lost one per cent. of water, 3.5 per cent. of volatile matter, and gained 4.5 of fixed carbon.

If we take 8080 as the heat units of carbon and 11175 as the heat units of the combustion of the combined volatile matter and deduct 2000 units for the heat expended in their expulsion, we have the respective value of fresh and weathered coals.

FRESH COAL.

Carbon .5050x8080	4080
Vol. matter .4350x11175—.4350x2000	3891
Total heat units in fresh coal	7971

Same sample weathered in the office for about six years:

WEATHERED COAL.

Carbon .5500x8080	4444
Vol. matter .4000x11175—.4000x2000	3670
Total heat units in weathered coal	8114

So that instead of losing in caloric value by weathering there is a decided gain of 143 units of heat.

A fresh sample of block coal taken from the Carbon Block Coal Co.'s mines gave:

Carbon	55.25
Volatile matter	39.85
Water	
Ash	

The same sample after weathering in the Geological rooms for five years gave:

Fixed carbon	59.50
Volatile matter	37.00
Water	
Ash	

A cubic foot of this coal lost 6.07 pounds of its weight, 1.9 per cent of hygroscopic water and 2.85 per cent. of volatile matter and gained 4.25 per cent of fixed carbon.

We now proceed to calculate the heating power of this non-caking coal in the same manner as for Dick's caking coal and it will be seen that weathering has the effect to also increase its evaporative value:

FRESH SAMPLE.

Carbon .5525x8080	4464
Vol. matter .3985x11175—.3985x2000	3556
Total units of heat	8020

Same sample five years weathered:

Carbon .5950x8080	4807
Vol. matter .3700x11175—.3700x2000	3394
Total units of heat	8201

The gain in heat power by weathering five years is therefore equal to 181 calories.

The relative value of the above coals as determined by their calculated or theoretical units of heat produced by combustion may be more readily understood by reference to the pounds of water which one pound of the coal will raise from 0° C. (32°F.)to 100° C. (212°F.)

Dicks' coal, fresh, 1 lb. will raise 79.71 water.

Dick's coal, weathered, 1 ℔ will raise 81.14 water.

Carbon Coal Co., fresh, 1 lb. will raise 80.20 water.

Carbon Coal Co., weathered, 1 lb. will raise 82.01 water.

This investigation is very important from the fact that it is generally believed that coal which is long from the mine deteriorates in value as a fuel and that caking coals part with their caking properties in so great a degree that

coals which make good coke when fresh mined will make but indifferent coke after they have been stocked for a period of time.

By the proximate analyses of the above coals no difference could be detected in the caking or fusion of the carbon, and in each case the coke from the respective coals gave evidence of being just as good from the five or six years weathered samples as when fresh from the mines.

In this connection I will mention that it is stated in Dana's System of Mineralogy, article "Mineral coal," p. 754, that "caking coal will loose its caking quality if kept heated for two or three hours at 300° C. (572°F.) and sometimes by mere exposure to the air." This temperature it will be remembered is nearly as great as that of molten lead (617°F.)

The conditions under which the experiment was made, are not given, but with such a temperature and exposed in an open vessel the greater portion of the volatile matter might be so gradually expelled in the time specified that the coal will cease to fuse in the process of coking

A number of experiments have been made in this laboratory to test the effect produced on various kinds of bituminous coals by subjecting them to moderate heat in an air tight vessel arranged somewhat after the form of a digester suggested by Prof. Carmichael for dissolving substances in acid under pressure. The result of these experiments are given in table No. 3, on page 23.

Niblock, Zimmerman & Co. and Woodruff & Fletcher's are block coals; all the other samples, with the exception of the cannel coal from Daviess county, are caking coals. The Connellsville sample was the same used in former experiments and was at least four months from the mine, one month of the time in the dry atmosphere of a room heated with a stove.

This coal heated up to 212° F. for twelve hours in the digester lost .2 per cent. of volatile matter, .5 per cent. of fixed carbon, and in twenty-four hours, at the same temperature, it lost .3 per cent. of vol. matter and 1 per cent. of

TABLE NO. III.

Table showing Loss in certain Coals by exposure in Digester for different periods at 212° F., and the coke from the same.

	One Hour.		Twelve Hours.		Twenty-four Hours.		Forty Hours.		Six Hours at 572° F.	
	Loss in air bath.	Coke from proximate analysis.	Loss in digester.	Coke.	Loss in digester.	Coke.	Loss in digester.	Coke.	Loss in digester.	Coke.
Woodruff & Fletcher, Clay County—3 years old...........	3.50	60 50	....	....	5.00	61.00	....	....	....	....
Niblock's Block Coal, Clay County—fresh specimen.......	6 00	52.50	9.00	57.50	....	....	....	....	....	....
....	8.50	59.00	....	....	9.00	61.40	....	....	....	....
....	2 50	56.50	3.10	57.10	5.20	57.00	6.50	57.00	5.00	57.00
....	3.50	53.50	3.30	55.50	3.30	55.50	1.70	55.50	[illegible]	57 50
....	4.50	62.50	1.20	62.50	3.00	62.50	1.70	62.50	7.50	61.00
....	3.50	61.50	2.00	61.50	3.50	62.00	2.10	62.50	6.20	62.50
....	3.50	55.00	3.10	58.00	4.30	57.50	2.80	58.00	7.60	56.00
....	4 50	71.50	0.70	72.00	0.70	70.00	....	....	....	....
....	4.50	71.50	0.20	71.00	0 30	70.50	0.30	70.50	1.10	71.50
....	11.50	53.50	....	....	9.70	56.60	....	....	....	....
....	10.50	52.50	....	....	9.00	55.00	....	....	....	....
....	3.50	50.50	0.60	50.50	2.30	50.50	1.80	50.50	3.10	50.50

fixed carbon. Heated forty hours at the same temperature the result was the same as in the last experiment.

Heated for six hours at 572° F. it lost 1.10 per cent. of its weight and gave 71.50 per cent. of coke, the same as obtained from the raw coal. There was no apparent difference in the swelling of the coke from the raw coal and that which had been kept at a temperature of 572° F. for six hours.

The samples of caking coal from Arbuckle & Budd's mine, Seelyville, Vigo county, and Hartford mines, same county, had been in the laboratory about two weeks before analyzed.

Chandler's coal from Vanderburg county was retained in the cellar about a month previous to being analyzed.

The block coal from Niblock, Zimmerman & Co's mine had been on hand about a week in the coal house. These are marked "fresh" in the table.

Arbuckle and Budd's coal heated, respectively, for twelve and twenty-four hours at 212° F. lost 3.30 per cent. in weight, while the fixed carbon gained 2 per cent. in weight. Heated for forty hours at same temperature it lost 1.70 per cent. in weight, while the fixed carbon remained the same. Heated for six hours at 572° F. it lost 3.50 per cent. in weight which corresponds to the whole of the water expelled by drying in the air bath, and gained 4 per cent. in fixed carbon.

The Hartford coal, while it lost 3.10 per cent. in twelve hours, 5.20 per cent in twenty-four hours and 6.50 per cent. in 40 hours, at 212° F., the fixed carbon remained the same in each experiment and was not changed by the temperature of 572° F. to which it was subjected for six hours, though it gained 1 per cent. in weight.

Chandler's coal from Vanderburg county, heated in the air tight digester at 212° F. for twelve hours lost 3.10 per cent. of its weight and gained 3.50 per cent. of fixed carbon; in twenty-four hours at same temperature it lost 4.30 per cent. of weight and gained 3 per cent. of fixed carbon; in forty hours the loss was only 2.80 per cent. while the fixed

carbon remained the same as in the twelve hour experiment. Under a temperature of 572° F. for six hours the loss of weight amounted to 7.6 per cent. and the fixed carbon was 2 per cent. less than when heated for twelve hours at 212° F.

The caking coal from Dick's mine and Henry K. Wilson's coal were both from Sullivan county. The former had been in the office five and the latter four years when treated in the digester. Both were analyzed when fresh from the mine and the results are here given for comparison with those after four and five years seasoning.

Dick's coal, top part, when fresh	52.00
Dick's coal, top part, after five years seasoning	62.00
Gain of fixed carbon in five years	10.00
Dick's coal, bottom part, when fresh	54.50
Dick's coal, bottom part, after five years seasoning	61.50
Gain of fixed carbon in five years	7.00
H. K. Wilson's coal,* when fresh	52.40
H. K. Wilson's coal, treated in digester after five years seasoning	69.00
Gain of fixed carbon	16.60

The Daviess county cannel coal when nearly fresh from the mine contained:

Fresh coal, - -	Water 2.50	Coke	48.50
After three years,	" 3.50	"	50 50
Gain of fixed carbon			2.00

As shown in table No 3, p. 23, heating in the air tight digester even up to 572° F. for six hours made no change in the yield of fixed carbon.

We had no old sample of Niblock's block coal for comparison. A fresh specimen heated for twelve hours in the digester at 212° F. lost 9 per cent. in weight and gained 5 per cent in fixed carbon.

The following statement will show the change which

*On account of losing the only sample we had of this interesting coal the amount of coke it yields after five years exposure can not be given.

Woodruff & Fletcher's block coal underwent during two years exposure in this office, and under the influence of 212° F. in the digester for twenty four hours.

Fresh coal yielded water 4.50	Coke	53.50
Old coal yielded " 4.00	"	60.50
Gain of fixed carbon in two years		7.00
Two year old coal gave coke		60.50
Same after exposure in digester 24 hours		61.00
Gain of fixed carbon		.50

The deductions to be drawn from the foregoing experiments are:

1st. That the volatile hydrocarbon constituents of bituminous coals undergo a decided change by exposure to the air at common temperatures. The effect of this change is to render non-volatile or to fix a portion of their carbon element whereby the percentage of coke is increased and that of the volatile matter diminished. The excess of carbon is greater in some coals than in others, most in caking coals and least in cannel coals. The maximum amount of change when under shelter, may be reached by some coals in less than five years.

2d. That the same result may be brought about by subjecting the coal to a temperature of 212° F. for a period of twelve to forty hours in an air tight digester.

3d. That while the volatile matter diminishes in quantity and may be less valuable for manufacturing illuminating gas, as a fuel, the coal is increased in calorific power and becomes more valuable with age, owing to the unstable nature of the volatile matter in coals.

It becomes a question of very great importance to the analyst to know what length of time and at what temperature coals should be exposed in order to expel the hygrometric water which they contain. Prof. S. Heinrichs has given some very valuable results on this point, in the Iowa Geological Report for 1868, deduced from the analyses of Iowa coals. He found these coals when powdered and exposed for one hour to a temperature of 115° C. (240° F.)

lost their maximum weight or hygrometric water, after which time they began to increase in weight. This increase he believes is due to the oxidation of bitumen. Since the publication of Prof. Heinrichs' analyses his views have, in the main, been adopted by chemists, and thirty to sixty minutes have been generally taken as the proper length of time, and 212° to 250° F. as the best temperature for expelling the moisture without changing the weight of the coal by decomposing some of its hydrocarbon constituents.

In order to determine the effect of prolonged drying on Indiana coals, a sample of caking coal, containing only 1.5 per cent. of ash, from Dick's mine, Sullivan county, and a block coal from Barnett's mine, clay county, containing 1.5 per cent. white ash, were pulverized and a centigram of each was weighed in platinum capsules and then placed in a copper air bath with thermometer attached and maintained at a temperature of 212° F. Two samples of Pennsylvania caking coals, one from Connellsville, the other, Stone's gas coal from Fayette county, were subsequently treated in the same manner and the results are given in Table 4, on page 28.

It will be seen in this table that the maximum amount of loss was reached by all the coals in two and a half hours. At three and a half hours they began to increase in weight and this increase continued to the end of seven hours, which closed the day's work, and Dick's and Barnett's were left over night exposed to the atmosphere of the laboratory. The next morning, after a lapse of twelve hours, Dick's coal only showed a loss of 0.5 per cent. and Barnett's had completely regained its original weight of a decigram. As the air bath would only hold two samples at a time, these coals were now thrown away and their place given to the two Pennsylvania coals, which were left in the air bath for sixty two hours to test the point of maximum increase of weight.

At the end of fourteen hours Stone's coal had increased .0025 or 2.5 per cent; and the Connellsville .0029 or 2.9 per cent. They were returned to the hot air bath and

TABLE NO. IV.

SHOWING THE EFFECT OF CONTINUED HEATING OF COALS IN AIR BATH AT 212° FAHRENHEIT.

	Dick's Coal, Sullivan Co., Indiana.	Barnett's Coal, Clay Co., Indiana.	Stone's Gas Coal, Pennsylvania.	Connellsville Coking Coal, Pennsylvania.
After ½ hours exposure it lost.......	3.2	2.6	1.0	0.8
After 1 hours exposure it lost.........	3.4	2.7	1.1	0.85
After 1½ hours exposure it lost..... ..	3.5	2.7	1.1	0.85
After 2 hours exposure it lost........	3.6	2.8	1.1	0.9
After 2½ hours exposure it lost.......	3.65	2.8	1.15	1.0
After 3½ hours exposure it lost.......	3.6	2.7	1.1	1.0
After 4 hours exposure it lost.........	3.55	2.5	1.1	0.95
After 4½ hours exposure it lost.......	3.4	2.5	1.05	0.9
After 5 hours exposure it lost.........	3.3	2.4	1.0	0.9
After 5½ hours exposure it lost.......	3.3	2 35	0·95	0.8
After 6 hours exposure it lost.......	3.2	2.3	0.9	0.8
After 6½ hours exposure it lost.......	3.2	2.3	0.9	0.75
After 7 hours exposure it lost.	3.15	2.25	0.85	0.7
After 7½ hours exposure it lost.......			0.8	0.65
After 14 hours exposure it gained...			2.5	2.9
After 22 hours exposure it gained...			2.5	3.8
After 62 hours exposure it gained...			6.0	8.3
After 90 hours exposure it gained...			5.8	4.75
After 140 hours exposure it gained.			5.8	

weighed again at the end of eight hours additional exposure; Stone's showed no change in weight but the Connellsville had increased to .0038 or 3.8 per cent. After a continued exposure of forty hours longer Stone's had increased to .006 or 6.0 per cent. and Connellsville .0083 or 8.3 per cent.

Total hours in hot air bath 60
Maximum gain of Connellsville.......................... 8.3 per cent.
Maximum gain of Stone's................................ 6.0 per cent.

It is difficult to account for so great a gain in the weight of these coals by exposure to the moderate temperature of 212° F. for sixty-two hours.

Fresh portions of the same coals after a lapse of one week, during which time they had been exposed to the dry atmosphere of the laboratory, were again placed in the hot air bath, and kept at a temperature of 212° F. for ninety hours. Connellsville gained in weight .00475 or 4.75 per cent. It was then charred or coked in the usual way and gave 76.03 per cent of coke which was incoherent and poured from the crucible like so much black sand.

Stone's gas coal gained in ninety hours, 5.8 per cent. It was returned to the air bath for fifty hours longer and no change in weight was apparent. It was then charred and gave 71.92 per cent. of coke which presented the same appearance as that from the Connellsville coal.

By referring to the proximate analyses of these coals we find that the unheated coals gave:

Connellsville	70.50 per cent.
Ninety hours at 212°	76.03 per cent.
Showing an increase in fixed carbon of..	5.53 per cent.
Coke from Stone's coal, fresh	64.50 per cent.
Coke from Stone's coal, after 90 hours at 212°	71.92 per cent.
Showing an increase in fixed carbon of..	7.42 per cent.

I can not agree with Prof. Heinrichs that the increase in weight given to bituminous coals by a prolonged exposure at a moderate temperature in the hot air bath is due to the oxidation of carbon, but rather to the oxidation of hydrogen, since the oxidation of carbon will result in its expulsion as $C. O.$ or $C. O_2$ and thus reduce instead of promote the increase of weight and the fixed carbon shown by the above experiments. It is my opinion therefore, that the change which takes place is due to the oxidation of the hydrogen of the marsh gas, $C. H_4$, to form $C\ H_2 + H_2\ O. = C. + 2\ H_2\ O.$

A portion of the increased weight is also due, in cases

where sulphide of iron ($Fe S$) present in the coal, to the oxidation of the sulphur into proto-sulphate of iron ($Fe O, S O_3 + H_2 O$).

It is of course difficult in the absence of a knowledge of the elements of the coal determined under the various conditions to which it has been subjected, to indicate the precise nature of the change which has taken place in its constituents, in order to produce so remarkable a difference in its composition as we see brought about by weathering or by the application of moderate heat, either while exposed to the influence of the atmosphere or in a closed vessel.

In addition to hygrometric water, mineral coal encloses a large volume of gas similar in composition to those known to occur in mines, that is, carbonic acid, oxygen, nitrogen and marsh gas. E. Meyer has examined coals from several coal fields in Germany and from the New Castle and Durham districts in England, and found in both fresh raised samples and samples that had been weathered from one to five years, a ready flow of enclosed gases Some Durham coals enclosed as much as three times their own volume of gases. The quantity was less in the weathered coal and contained but little or no marsh gas ($C. H_4$), but a considerable per cent. of heavy carburetted hydrogen ($C_2 H_6$). Meyer considers the absence of marsh gas in the weathered specimens due to its great diffusibility. Samples of the same coal containing marsh gas, when heated to a temperature of 45° C. (113° F.) for two days lost all trace of this gas, but there was developed in its place heavy carburetted hydrogen ($C_2 H_6$).

Another coal heated to 50° C. (122° F.) gave similar results $C.H_4$ disappeared and $C_2 H_6$ made its appearance.

In every case the volume of enclosed gas is lessened by weathering at ordinary temperatures, or by subjecting the coal to moderate heat. The important question suggested by these interesting experiments by Meyer is: whence comes the $C_2 H_6$? His analyses indicate that the hydrogen was oxydised by the oxygen of the coal and not by that contained in the atmosphere. May it not be possible then

that $C_2 H_4$ is formed by the oxidation of one equivalent of hydrogen from the marsh gas ($C.H_4$) leaving $C.H_3 = C_2 H_6$. Since the oxidation of hydrogen will alone account for an increase of carbon in the enclosed gases it may also account for the conversion of volatile hydrocarbon into solid carbon, as shown by weathering and also by subjecting the coal to a temperature of 212° F. in the air tight digester. But it will not account for the increase of weight under prolonged heating in the air bath after all water and enclosed gases have been expelled, for this requires the addition and not the subtraction of matter, and the latter must be obtained from the atmospheric oxygen.

If moderate heat and pressure have the effect to increase the per cent. of carbon in bituminous coals, then it is not necessary to look for any extraordinary physical phenomena to explain the formation of beds of anthracite, since these causes are sufficient to account for their containing so little volatile combustible matter.

M. L. Gruner in his very able treatise on the classification and heating power of coals* endeavors to show that the industrial value of coal is more accurately obtained by proximate than by elementary analysis since the greater the amount of carbon and the less the volatile matter a coal contains the greater will be its heating power, or in other words, the heating power of a coal depends upon the amount of coke which it yields. While I am ready to admit that proximate analysis will teach us very much in regard to the physical peculiarities of coal, it can not justly be claimed as conveying to the consumer its real industrial value. The rapid change which the relative proportion of fixed carbon undergoes by weathering and the variations which are made in its determination by rapid and slow distillation or by increasing or diminishing the heat, all admonish us of the impossibility of drawing accurate conclusions by a comparison of the proximate analyses of coals made at different times by different analysts and under unknown conditions of the sample analysed. Nor

*Engineering and Mining Journal, 18th July 1874. Translated by R. P. Rothwell, M E.

will it do to refer to the American experiments by Walter R. Johnson, or to those made by the English admiralty for the evaporative value of coals as the touch-stone by which to compare the value of more modern results, since they are imperfect in modès and totally without value for comparison.

By an elementary analysis we find the total amount of carbon and hydrogen, and since these elements, singly or combined, represent all that is combustible in coal or capable of producing heat, no matter whether the sample be fresh or weathered, provided the results are rendered from coal that has been previously dried for one hour in a hot-air bath at a temperature not less than 212° F, therefore, if we wish to make a perfect study of coal, I can not see how it is possible to dispense with its teachings. Not only does it furnish the carbon and hydrogen, but those elements which, by their expulsion, act as absorbents of heat.

But I am free to admit that by using proper care in making proximate analyses of coals, such as paying strict attention to see that the specimens after leaving the mines are kept similarly exposed to meteorological changes, then dried and charred at similar temperatures, that such results are comparable with one another and we may very fairly arrive at their heat units by Dulong's formula and using the accurate determination of Favre and Silberman of the heat units of carbon burning to carbonic acid, $C.O_2$ and those of the volatile combustibles of coal burning to form water and carbonic acid, and of hydrogen burning to form water, *i. e.*, one grain of carbon burning to carbonic acid will raise 8080 grains of water from 0° C. (32°F.) to 1° C. (33.4° F,) one grain of hydrogen burning to form water, (H_2 O.) will raise 34462 grains of water from 0° C. to 1° C. The constituents of coal gas by weight and their heat units are:

Hydrogen	5 x 34462=	172310	heat units.
Marsh gas	61 x 13061=	797843	heat units.
Olefiant gas	10 x 11858=	118580	heat units.
Carbonic oxide	12 x 2403=	28836	heat units.
Carbonic acid, nitrogen, etc.	nil.	nil.	
		1117569	

1117569 ÷ 100 = 11175 heat units for the combustion of coal gas. That is, one grain of volatile combustible matter of coal when burned will raise 11175 grains of water from 0° C. to 1° C.

If now, we use Dulong's formula for calculating the calorific value of coal by the heat units of its combustible constituents and deduct 2000 heat units for every unit of volatile matter in the dry coal, as heat lost in their expulsion, and then compare the results deduced from the proximate analysis with those obtained from the elementary analysis of the same coal, they will be found to agree so closely that it will be quite safe under the conditions already stated, to adopt this mode of calculating the relative evaporative power of coals by means of a knowledge of their proximate constituents alone.

In the Gas Works,* at Indianapolis, it is found that it requires about 16 pounds of coke to expel the volatile matter from 100 pounds of coal. I have therefore assumed, upon the basis given by Mr. Bell, 2000 as the number of heat units required to expel one unit of volatile matter, instead of 1895, and have taken the determination of carbon heat units, as established by Faver and Silberman, and the exact figures given by Bunsen for the heat units of the volatile combustible matter of coal.

The following examples will serve to illustrate the two modes of making the calculation.

The sample taken, block coal from the Star mines, Clay

*Mr. I. Lowthian Bell ascertained that, at the New Castle Gas Works, 15 pounds of coke were used to expel the gas from 100 pounds of coal. The 15 pounds of coke contained eight-tenths of a pound of ash and a deduction of one-third was made, from the heat units, for radiation and waste by the chimney:

15 coke = C 14.2 x 8000 =	113600
Less one-third for waste	37800
Net calories evolved by burning 100 pounds of coal	75800

Admitting the general correctness of this estimate, each unit of volatile matter requires 1895 heat units. "Chemical Phenomena of the Blast Furnace," p. 306.

county, Indiana, being one of the few coals which were simultaneously analysed, ultimately and proximately.

Ultimate analysis gave:

Ash	.0100
Carbon	.8270
Hydrogen	.0477
Oxygen	.0881
Nitrogen	.0174
Sulphur	.0098
	1.0000

The combustion of the carbon will give: C. 8270 x 8080 = 6682 carbon calories.

Hydrogen, after deducting the amount which combines with the oxygen, gives: H. 0389 x 34462 = 1340 hydrogen calories. Throwing off the fractions in each instance, we have 6682 + 1340 = 8020 coal heat units.

The same coal, by proximate analysis, gave:

Ash, white	.010
Carbon	.630
Gas	.325
Water	.035
	1.000

Heat of combustion calculated as before; Carbon .630 x 8080 = 5090 carbon calories. Volatile combustibles .325 x 11175 = 3611 units, but this will require .325 x 2000 = .650 units of heat to expel it, then 3611—650 = 2961 calories available for heat, then:

Carbon	5090	heat units.
Volatile matter	2961	heat units.
Gives	8051	total coal calories.

We may therefore, with very great propriety, adopt this rule for estimating the evaporative power of coal.

Manner of conducting the analysis of coal:

It is a matter of no little difficulty to select from a mine a proper sample for analysis, at least such a sample as will represent the average commercial value of the seam.

The best way, therefore, is to take samples from the top, middle and bottom parts of the seam. These should be carefully labeled, wrapped in paper and sent to the laboratory as soon thereafter as practicable. On arriving at the laboratory, they should be taken in hand at once. About a pound of each sample should be pulverised fine enough to be passed through a porcelain colander with one-tenth inch perforations. Then transferred to bottles with good cork stoppers. Each bottle should be labeled, showing the date of mining, when bottled, name of mine, etc. These bottles serve as stocks from which the different quantities are to be taken that serve for analysis. It is not a good plan to mix the portions taken from different parts of the seam and consider the mixture an average sample so that one set of analyses may serve; for though it might furnish a fair statement of the commercial value of the seam, it would leave us in ignorance of much useful information in regard to the true character of the seam.

PROXIMATE ANALYSIS.

One gram. is charred in a covered platinum crucible of about one fluid ounce capacity. The heat is derived from a three-jet Bunsen gas burner and the crucible is kept at a bright red heat until the escaping gas ceases to burn and the condensed carbon disappears from the cover. The weight of the charred mass gives the coke, and the volatile matter is estimated by the loss. To determine the hygroscopic water, one decigram of pulverised coal is weighed in a small, shallow, platinum capsule and placed in a hot air bath where it remains at a temperature of 100° to 105° C. for one hour, the loss gives the water. The capsule, with the dry coal, is then placed over the strong flame of a Bunsen burner until it is consumed to ash.

The weight of the ash is deducted from the coke to find the fixed carbon and the weight of the water is deducted from the total volatile matter to find the per cent. of combustible gas.

All this appears very simple but it requires great care and

attention in order to obtain reliable results. The temperature of 100° C. (212° F.) is recommended, since it is believed that a higher temperature is no more effective and is more liable to produce decomposition of the volatile constituents.

ELEMENTARY ANALYSIS.

The combustion is best performed in a hard glass tube, twenty inches long and three-quarters of an inch in diameter. Twelve inches of the posterior end is filled with a tightly rolled coil of fine copper gauze. This is oxidised by drawing air through the red hot tube with an aspirator. The usual appliances are used to dry the oxygen and free it from carbonic acid and other impurities, and also arrest the hydrogen, sulphur and carbonic acid.

Previous to commencing the combustion a current of pure oxygen is passed through the heated tube to complete the oxidation of the copper and expel the last trace of moisture. Two decigrams of pulverized coal are now placed in a platinum boat and inserted in the anterior part of the tube about three inches from the copper. The heat of the gas furnace is applied with due precaution and the combustion is completed when the coal has been burnt to ash and oxygen bubbles pass freely through the potash apparatus. When the hydrogen, sulphur, potash apparatus and potash U tube have been weighed, another analysis may be proceeded with and in this way as many as four combustions may be made in a day. A good tube will serve for ten or twenty combustions. The potash apparatus should be renewed after every third combustion in order to insure a proper absorbtion of the carbonic acid.

The advantages to be derived from this mode of conducting the analyses, are: You are enabled to watch the combustion of the coal and see when it is completed; the ash may be determined at the same time and the tube is at once ready for the reception of another sample of coal; nitrogen is determined by Varrentrapp and Will's method, *i. e.*, by conversion into ammonia. The ammonia is received in a measured quantity of standard oxalic acid, and the

amount of free acid remaining is determined by neutralizing with a standard solution of soda. The quantity of acid saturated by ammonia is then found from the difference.

DETERMINATION OF SULPHUR AND PHOSPHORUS.

There is, generally speaking, less reliance to be placed in the published statements of the amount of sulphur and phosphorus in coals than in any one of its other elementary constituents. The results are, as is well known, generally under rather than over the actual amount of sulphur present in a coal. The loss is due to a portion of the sulphur being converted into sulphuretted hydrogen, and the phosphorous into phosphoretted hydrogen, which escapes during the process of dissolving the coal. In order to avoid this loss, five decigrams of coal are fused with eight grains caustic potash and two grains nitrate of potash in a silver crucible.

Both the caustic potash and nitrate of potash should be tested for sulphur and the per cent. marked upon the bottle.

The half gram powdered coal is placed in the crucible and moistened with alcohol, eight grams potash is then put in with the coal and placed over a moderate heat until the potash is melted, after which two grams nitrate of potash is added, the whole is kept at a gentle heat for about two hours or until all the moisture is expelled; the heat is then increased until all ebullition ceases. The coal should dissolve without deflagration from ignition. After cooling, the contents of the crucible are dissolved out with water and neutralized with hydrochloric acid, evaporated to dryness, moistened with hydrochloric acid and re-dissolved with water. Filter out the silicic acid, heat the filtrate and precipitate the iron and alumina with ammonia and determine the sulphuric acid in the filtrate with chloride of barium.

The phosphoric acid is precipitated with the iron, and to separate it, the precipitate is dissolved from the filter with a weak solution of hydrochloric acid, and then evaporated to dryness to separate the last trace of silicic acid. Moisten with nitric acid, dissolve in water, filter and precipitate the

phosphoric acid with molybdate of ammonia. Wash the precipitate as directed by Fresenius, dissolve with ammonia and precipitate phosphoric acid with sulphate of magnesia. In order to determine the per cent. of iron and alumina, it is better to take another half gram of coal and fuse as before. The iron and alumina are then precipitated from the hot solution with ammonia and the alumina is separated by digesting the precipitate with hydrate of potassa in a silver crucible.

This mode of determining the sulphur, phosphorous, iron and alumina in coal, is simple, expeditious and accurate. It has been adopted after repeated trials of all other known processes and leaves nothing to be desired. Owing to want of time these deleterious ingredients have not been determined in the following coals, but the proximate analyses have been determined with great care. This deficiency will be supplied in future reports as well as other important investigations to render their commercial value more definitely understood; for after years of experience in the study of coal analyses, it is only within the last year I have hit upon modes that can be relied upon as furnishing the necessary information regarding the physical and chemical constitution of this mineral.

REVIEW OF THE GEOLOGICAL WORK ACCOMPLISHED DURING THE YEAR.

Professor John Collett has made a classification of the coal seams and their accompanying rock strata in Vanderburg and Owen counties, as well as some additional investigations in the south and southwestern part of Clay county where there has been very important mining operations instituted since the report of 1869. Also, a detailed survey of Montgomery county.

Professor Borden finds in his survey of Ripley and Jennings counties the most westerly crop of the Cincinnati rocks in the northeastern part of the latter county and the most easterly crop of the Niagara and Clinton along the

waters of Laughery creek in Ripley county. The Cincinnati rocks in the latter county have an aggregate thickness of 190 feet. The Niagara 42 feet. There is a hiatus in the chronology of the strata from the Niagara to the Quaternary beds. The latter period is represented by glacial drift and Champlain 35 feet, and from 2 to 25 feet of alluvial clays and soil. The geological section of Jennings contains a thin crop of Cincinnati rocks which are 32 feet thick in the northeast part of the county, 40 feet of Niagara, 74 feet of Devonian strata, Corniferous 18 feet; building stone, equivalent of the hydraulic cement beds of Clarke county, 11 feet; Gennessee shale of New York reports, "New Albany black shale," 45 feet.

The lower carboniferous and coal measures are entirely absent, and we come next in the ascending order to the Quaternary, which appears in about the same force as in Jennings county. The Hamilton beds in this county furnish some of the best building stones in the State. For a detailed account of the various formations and the economical value of their minerals the reader is referred to Prof. Borden's Report in another place in this volume.

The survey of the inland lakes, in the northern part of the State, conducted by Dr. G. M. Levette, assisted by Caleb Cooke, of Peabody Academy, Salem, Massachusetts, was productive of many important results as will be seen by reference to the report. Up to the time of this survey it was currently believed that many of these beautiful lakes had a very great depth of water, some indeed were commonly called "bottomless lakes." The greatest depth of water found in any examined did not exceed 52 feet while some of the so called "bottomless lakes" had a depth of only 9.5 feet. The temperature of the water was taken with one of Green's deep-sea thermometers and carefully noted at different depths, which showed a uniform decrease in the temperature from the surface to the bottom. Pine Lake, in Laporte county, had a surface temperature of 68° F. and at the bottom 52 feet the temperature was 55° F. An apparent exception to the rule of a gradual decrease in

the temperature toward the bottom was met with in Stone's Lake, Laporte county, where the thermometer fell from 66° at 28 feet to 56° at 30 feet, a difference of 10° in two feet. This rapid change of temperature is no doubt properly attributed to the presence of springs of cold water which rise from the bottom. The water of these lakes is remarkably clear and free from mineral matter. An analysis was made of the water from Lake James in Steuben county. It is clear and has a pleasant taste and is neutral to litmus paper.

An imperial gallon (10 pounds) contains 10.5 grains of solid mineral matter, composed of

Bicarbonate of lime	7.00 grains.
Iron, alumina and silica	2.10 grains.
Magnesia and undetermined	1.40 grains.
	10.50

It contains no more mineral matter than is commonly present in river water and is not only a potable water in a most eminent degree, and may be drawn from the bottom with a temperature of 50° which is refreshingly cool without the addition of ice, but is likewise well suited for laundry purposes and for those branches of manufactures which require large quantities of water, such as the manufacture of fine writing paper, printing paper, etc.

The ancient shores of many of these lakes, for it appears that their water area has been constantly diminishing, are composed of chalk (carbonate of lime) of creamy tint almost white. This tint is due to organic matter since it only contains a trace of oxide of iron and the discoloration disappears when it is burnt. This chalk was at one time in common use for the manufacture of quick-lime, for which purpose it answers very well, but does not compare favorably in quality with the lime from Huntington, Peru and Delphi, nor can it be mined and burnt as cheaply as at the latter localities where the best of limestone is quarried at the surface crop. Samples of this fresh water chalk were

collected from various localities, two of which were analysed. One from the shore of a small lake on the farm of G. W. Slocum, Sec. 3, T. 37, R. 13, Steuben county. This sample contained in 100 parts:

Water at 212° F	8.00 per cent.
Carbonic acid and combined water	41.50 per cent.
Insoluble silicates	.30 per cent.
Oxide of iron	a trace
Alumina	1.50 per cent.
Lime	45.36 per cent.
Magnesia	3.42 per cent.
Sulphuric acid	.10 per cent.
Phosphoric acid	.38 per cent.
	100.56

The other sample analysed was taken from a bluff one mile north of Rome City, Noble county, that formed the border of a lake which has filled up by vegetation and formed a peat bog.

Composition in 100 parts:

Water at 212° F	3.00 per cent.
Carbonic acid and combined water	41.00 per cent.
Insoluble silicates	.70 per cent.
Oxide of iron	a trace.
Alumina	1.00 per cent.
Lime	49.84 per cent.
Magnesia	4.10 per cent.
Sulphuric acid	.03 per cent.
Phosphoric acid	.52 per cent.
	100.19

These chalks show a remarkable degree of purity, the insoluble matter in each case is less than one per cent., and they contain only a trace of iron. The discoloration is removed by ignition; it is pulverulent when dry and soft like mortar when first taken from the bank, and may be pressed into pencils and will mark like the common English chalk.

The deposits bordering some of the lakes, and which occupied the ancient bed of the lake, have a thickness, where penetrated by wells, of from twenty to thirty feet.

Specimens of this fresh water chalk were sent to Prof. Edwin Bicknell, of Cambridge University, and Dr. J. Gardner, of Bedford, Indiana, and to Dr. W. W. Butterfield, of this city, for microscopic inspection, and not one of these able microscopists could find in it either diatoms or the globigerina so characteristic of the marine chalk, nor any other forms of foraminifera. We are therefore brought to conclude, notwithstanding that the percentage of bicarbonate of lime is not greater than is commonly found in river water, that these great chalk beds are formed by chemical precipitation of the lime and magnesia from the water, brought about by the agency of the atmosphere and aquatic plants. In the absence of accurate knowledge regarding the annual rate at which this deposit takes place we may with reason assume that it progressed at the rate of one-tenth of an inch a year and at this rate the deposit of thirty feet required a period of 3,600 years for their accumulation. Long as this period may appear to many, it is plain to see, independent of other striking geological evidence, that it does not by any means represent the age of the lakes; since it is known that the deposition accumulates with far greater rapidity along the shores where the water is shallow and more under the influence of the sun's rays to elevate its temperature and dissipate the carbonic acid that held the lime in solution, so that the estimate should include a horizontal as well as verticle measurement of the accumulated chalk. By this means too the circumference of the lakes have been very greatly contracted and the chalk deposit may, in some instances, be followed inland for several hundred yards. Indeed in this way some lakes have been almost entirely filled up and the central portion formed into peat bogs.

While this chalk is available for the manufacture of quick lime it is far more valuable as a fertilizer. It will be found especially well suited when dried and pulverized to promote the growth of cereals and grasses on sand and clay lands. About two tons prepared in this way should be sown broadcast over an acre and then plowed in. It will have a

tendency to *warm* the soil and furnish lime, magnesia and phosphoric acid, being richer in the latter substance than most productive soils.

In addition to the investigations for temperature of the water of these inland lakes at serial depths, Dr. Levette was directed to take the temperature of the deep wells bored for artesian water at Fort Wayne, Allen county, and at Wabash, Wabash county. The well at Fort Wayne, at the time of his visit, was 2,635 feet deep, but has since reached a depth of 3,000 feet, where the work is suspended without having found water that rises to a greater hight than eight feet below the surface. The mouth of the bore, which is situated in the public square, is about thirty feet above the bed of the Maumee river, 228 feet above the level of Lake Erie and 793 feet above tide-water of the Gulf of Mexico. The first eighty-eight feet went through glacial drift where it struck the first rock, which is a light colored limestone belonging to the Niagara epoch and continues through limestone and calcareous shale to the depth of 2,500 feet; thence in soft calcareous rock to the bottom which is still in the Lower Silurian. The temperature of the air in the house covering the well and the machinery used in boring, was 70° F. The temperature of the water in the well was taken at 90 feet down, at 100 feet, at 1,000 feet, at 1,500 feet and at the bottom, 2,635 feet, and in each instance the thermometer registered 51½° F.

The well at Wabash was commenced in the Court House square, 85 feet above Wabash river, 186 feet above Lake Erie, and 751 feet above tide water in the Gulf. This bore started in the Niagara limestone, which shows itself in the street cut close by, and continued in limestone and calcareous shales to the depth of 2,270 feet without finding artesian water. Water was reached at 85 feet and it is believed by the parties who were employed to make the bore that several other seams of water were encountered. The temperature of the air at the surface was 85° F. and uniformly 50½° F. at 100 feet, 500 feet, 1,000 feet and 2,270 feet down.

The results obtained above were so different from what was expected, that special precautions were taken to prevent any possible error from derangement of the thermometer, which is one made expressly for the purpose by James Green, of New York, it was therefore subjected to the temperature of melting ice and found to be in perfect working order. The inference to be drawn from the uniform temperature of these wells, is, that they are filled with water that comes from an upper stratum and the temperature which it receives at that horizon is by means of the greater specific gravity of cold water carried down to the bottom. This constant supply of cold water from above counteracts the influence of internal heat. In this respect the deep wells correspond with the results obtained by the "Challenger" in the sheltered basins of the deep sea lying in the neighborhood of the Australian continent. These basins correspond to wells of large diameter and the temperature of the water within the rim was found to be the same from top to bottom.

The level of the water in the Wabash well stands on a level with that of Wabash river, since it is known to rise and fall with that stream and is topographically 96 feet below the surface of the water in the Fort Wayne well. But on the other hand the seam of water supply of the latter well lies some nearer to the surface of the earth.

Having determined the temperature of these wells, where the water does not reach the top, it was deemed important to make a test of some artesian well. Several wells had been bored at Terre Haute, in Vigo county, for petroleum, but owing to the moderate yield of oil and its low price in the market they have been abandoned and we only found one of the three wells that could be tested for temperature in any manner. This is a well owned by J. S. Miller and is situated in the edge of the city and on the bank of Wabash river, 93 feet below lake Erie, and 472 feet above tide water of the Gulf of Mexico. The drill commenced in the glacial drift, passed through the coal measures, Devonian and in my opinion stopped in the Niagara at the depth of

1923 feet and 4 inches. According to the record of the bore, it went through five seams of coal. The first seam at the depth of 164½ feet which is 6.2 feet thick; at 183 feet, coal 3 feet thick; at 216 feet, coal 9 inches thick; at 224 feet, salt water with gas; at 262 feet, coal 2 feet 3 inches thick; 308 feet, coal 3 feet 3 inches; sulphur water first appeared at a depth of 980 feet but the present flow, it is believed, comes from the bottom of the well and if piped so as to confine the water it will rise to the hight of 30 feet above the surface. The water belongs to the class known as saline sulphuret. At out-flow the water has a temperature of 81° F. and continued the same to the depth of 100 feet where the thermometer was stopped by some obstruction that prevented its further descent. There can be no question but the temperature of 81° will be found persistant to the bottom. This well fully confirms the conclusions which had already been reached, that the temperature of these bores is dependent upon the temperature of the water which fills them, and the latter is determined by the horizon from which it is derived. It is now generally admitted that the earth was once in a state of liquid incandescence and that it has been gradually cooling. In this way the outer surface became a solid crust and finally so much reduced in temperature as to render it the fit abode of plants and animals.

Physicists have determined by observations on the manner in which the earth attracts the moon and by experiments made with the pendulum that the earth can not be an empty sphere. And by observations on the precessional motion of the pole of the earth, Mr. Hopkins undertakes to show that the solid crust can not be less than from 800 to 1,000 miles, but, as Lyell remarks, "this does not preclude us from imagining that great lakes and seas of melted matter may be distributed through a shell of 800 miles thick." Though the thermal condition of the central part of the globe is a subject which has long elicited the attention of mathematicians and philosophers, the solution appears to be still far from being definitely settled. By the study of deep

mines and deep bores certain facts have been attained which go to show that under varying conditions there is a regular increment in temperature of the earth's crust as you descend below the external stratum. According to Bishoff the heat increases more rapidly in schists than in granite, still more rapidly in metallic veins and more in lodes of copper than in those of tin, and most of all in beds of coal. From the irregularity found to exist in the temperature of artesian wells they have not proved to be a reliable means of determining the true rate of increase in the temperature of the earth's strata.

In an artesian well in Wurtemburg the temperature increases 1° F. for every 19 feet of descent. In two wells, one in Durham the other in Manchester, each 2,000 feet deep, Mr. Phillips found the temperature to increase 1° for every 65 to 70 feet in depth. In the silver and lead mines of Saxony the increase was found to be 1° for every 65 feet. While in other mines in the country it was found necessary to descend three or four times as far for one degree of heat. In Cornwall, England, at a depth of 1,380 feet the mean temperature was found to be 68° F. which gives one degree for every 75 feet. The experimental well bored at Grenelle, near Paris, is 1,800 feet, or nearly the same as the Terre Haute well, gave an increase of 1° for every 60 feet. But the artesian well at the Royal Palace in Naples, is 1460 feet deep and has a temperature of only 68° and after deducting for the mean temperature at the surface, this gives a rate equal to one degree in 208 feet. Another well in the same city, only 900 feet deep, shows an increase of one degree in every 83 feet of depth. The difference in the rate of increase in these two wells may be due to an influx of cold water in the upper part of the well at Grenelle. These examples are given for the purpose of comparison with the results obtained from the well at Terre Haute, and if we may assume the mean temperature of the surface to be 50° F. at Terre Haute, we then have an increase of one degree for every 62 feet of depth which

agrees very closely with the observations made on the Durham and Manchester wells in England.

In estimating the temperature of the earth by observations on the temperature of artesian wells and mines, it is not only necessary to know the mean temperature at the surface, but the elevation above the sea should also be taken in consideration. In my opinion the most reliable way to arrive at the mean temperature of a locality is to adopt for it the temperature of well water where the depth is not less than 20 to 40 feet. For I have found that the temperature of well water at such depths represents very fairly the mean temperature of the surface and at all events furnishes a constant standard by which to calculate the rate of increment in deep bores. The deepest as well as one of the most instructive artesian bores of which I have any knowledge, is the one situated about 25 miles south of Berlin and bored by the Prussian government. For a depth of 291 feet it passed through gypsum and from thence it encountered salt for a distance of 3,881 feet without reaching the bottom of the mass. The total depth being 4,172 feet.

Professor Mohr, of Bonn, reports the temperature of this well to be as follows:

Depth.	Degrees F.	Increase per 100 feet.
700	67.22	......
900	72.16	2.47
1100	76.87	2.36
1300	81.37	2.25
1500	85.62	2.13
1700	89.65	2.02
1900	93.46	1.91
2100	97.03	1.79
3390	114.70	......

These observations show that the rate of increase of heat diminishes with the depth, and Prof. Mohr believes that at a depth of 5,170 feet a zone of invariable temperature will be reached.

Estimating according to the rate of increase shown by the investigations of Mohr, the temperature of the earth at the bottom of the Fort Wayne well will be about

108.88° F. but calculated by the assumption of one degree of increase for every 62 feet of depth, as furnished by the experiments on the Terre Haute well, it would give a temperature of $3000 \div 62 + 50 = 98.4°$ F.

The temperature found in the Prussian well is 93.46° at the depth of 1900 feet which is 12.46° higher than the water which issues from the Terre Haute well, and goes to show that the latter water is mixed with colder streams from above, or is from a horizon about 1500 feet below the surface, since the actual difference of temperature between the Prussian well and the Terre Haute and Fort Wayne wells at the respective depths given above, are about the same.

ANALYSES OF COALS.

One hundred and thirty-three samples of coal, representing sixty-nine different mines or out-crops, have been analysed during the year and the results are given on the following pages and in the tables of analyses in another part of the report.

CLAY COUNTY COALS.

Elias Cooprider's coal L on section 31, township 10, range 6, near Middletown, Clay county. This is a compact jet-black, slightly laminate, caking coal with some evidence of pyrites in the lower part.

	Top.		Middle.		Bottom.
Fixed carbon	44.00		45.00		50.50
Gas	47.50		44.00		42.50
Water	4.00		2.50		3.00
Ash ... pink	4.50	brown,	8.50	yellow,	4 00
Coke, per cent	48.50		53 50		54.50
Heat units	7924.		7673.		7980.
Specific gravity	1.280		1.533		1.211
Weight of 1 cubic foot	80.00		95.81		75.68

Coke: vitreous, puffed, amorphous.

John Cooprider's coal K on section 31, town 10, range 6 near Middlebury, Clay county. Coal L, 8 feet thick. A,

jet-black, compact, caking coal, breaks into irregular cubes and has some pyrites in the vertical seams.

	Middle.	Bottom.
Fixed carbon	44.50	41.50
Gas	47.00	47.50
Water	3.00	3.50
Ash, purple	5.50	7.50
Coke, per cent	50.00	49.00
Heat units	7808.	7711.
Specific gravity	1.271	1.274
Weight of 1 cubic foot	79.44	79.62

Coke: lustreless, puffed, amorphous.

Kennedy's coal near Centre Point, Clay county. Coal I, 4 feet thick. This is a dry, laminate, dull black, block coal, breaking into irregular fragments; shows charcoal partings and pyrites in the vertical seams. The bottom of the seam runs into caking coal with white clay in the seams.

	Top.	Middle.	Bottom.
Fixed carbon	46.50	49.50	52.00
Gas	35.00	39.00	40.50
Water	3.00	2.50	3.00
Ash brown,	15.50	white, 9.00	white, 4.50
Coke	62.00	58.00	56.50
Heat units	6968.	7575.	7917.
Specific gravity	1.354	1.204	1.188
Weight of 1 cubic foot	84.62	75.25	74.25

Coke: not puffed, vitreous, laminate, the bottom part showing a tendency to cake.

Knickerbocker Coal Company's shaft near Salem, Clay county. Coal I, 3 feet 2 inches thick. This is a dull black, block coal in thin laminæ with charcoal partings, breaks into irregular forms and is very strong across the lines of bedding.

	Top.	Middle.	Bottom.
Fixed carbon	55.00	52.50	50.50
Gas	37.00	39.50	40.00
Water	2.50	2.00	3.00
Ash buff,	5.50	white, 6.00	white, 6.50
Coke	60.50	58.50	57.00
Heat units	7838.	7774.	7750.
Specific gravity	1.167	1.184	1.241
Weight of 1 cubic foot	72.93	74.00	77.56

Coke: laminate, vitreous, not swollen.

W. R. Kress' coal I, on section 6, township 9, range 6, near Middlebury, Clay county. A dull black, slaty, block coal, running into caking coal at the bottom of the seam, has charcoal partings, is much stained with iron and shows pyrites at the bottom of the seam.

	Top.		Middle.		Bottom.
Fixed carbon	44.00		40.50		38.50
Gas	39.50		44.50		44.50
Water	3.50		4.50		4.00
Ash ... red,	13 00	brown,	10.50	gray,	13.00
Coke	57.00		51.00		51.50
Heat units	7179.		7355.		7194.
Specific gravity	1.318		1.287		1.432
Weight of 1 cubic foot	82.37		80.43		89.40

Coke: from top and middle laminate, vitreous, not puffed; from bottom, puffed, lustreless, amorphous.

Limited Liability Coal Co.'s coal, near Ashboro, Clay county. Coal I, 3 feet 10 inches thick. This is a typical block coal, in thin laminæ, separated by charcoal markings, very strong across the bedding and free from sulphur.

Fixed carbon	57.00
Gas	37.00
Water	3.00
Ash, white	3.00
Coke	60.00
Heat units	8000.
Specific gravity	1.231
Weight of 1 cubic foot	76.93

Coke: not puffed, lustreless, laminate.

Coal at Lodi, Clay county, 30 inches thick. A glossy, jet-black, caking coal, with pyrites in the partings.

Fixed carbon	43.00
Gas	40.50
Water	3.00
Ash, red	13.50
Coke	56.50
Heat units	7190.
Weight of one cubic foot	81.43
Specific gravity	1.303

Coke: puffed, lustreless, amorphous.

Markland Coal Co.'s coal, near Clay city, Clay county. Coal I, 3 feet 4 inches thick. This is a bright black, laminate, block coal with very distinct charcoal partings. Four inches of the middle of this seam is a glossy, jet black, caking coal, with only one-half per cent. of ash; it bears a close resemblance to the mineral Albertite from Nova Scotia. On exposure to the air, it breaks into small irregular fragments, and burns like a pine knot when once ignited. Underlying the bottom are 3 or 4 inches of bone coal, containing considerable pyrites, analysis not given.

	Top.	Middle.	Bottom.
Fixed carbon	58.00	63.50	59.00
Gas	36.00	33.50	36.00
Water	2.00	2.50	2.50
Ash, white	4.00	.50	2.50
Coke	62.00	64.00	61.50
Heat units	7989.	8205.	8070.
Specific gravity	1.202	1.145	1.221
Weight of 1 cubic foot	75.12	71.56	76.31

Coke from top slightly puffed, laminate, vitreous; from middle very much puffed, amorphous, vitreous; from bottom slightly puffed, amorphous, vitreous.

McClellan & Zeller's coal, north of Brazil, Clay county. This is a typical block coal, a dull, lustreless black, in thin laminæ, separated by fibrous charcoal partings, very strong across the bedding lines, free from pyrites and calcite and is highly esteemed for blast and puddling furnace use. The specimen analysed was fresh from the mine and held a large excess of water which on exposure to the air of the laboratory for a few weeks would reduce to about 3.5 per cent.

Fixed carbon	56.50
Gas	32.50
Water	8.50
Ash, white	2.50
Coke	59.00
Heat units, wet coal	7549
Heat units, dry coal	8000.
Specific gravity	1.285
Weight of 1 cubic foot	80.31

Coke: laminate, not swollen, lustreless.

John McCrea's coal near Hoosiertown, Clay county. Coal I. This is a dull black, semi-block coal in moderately thin laminæ, running into caking coal at the bottom of the seam; no pyrites visible.

	Top.	Middle.	Bottom.
Fixed carbon	56.50	56.00	58.00
Gas	39.50	36.00	37.00
Water	2.00	2.50	2.50
Ash, white	2.00	5.50	2.50
Coke,	58.50	61.50	60.50
Heat units	8189.	7828.	8080.
Specific gravity	1.196	1.229	1.227
Weight of 1 cubic foot	74.75	76.81	76.06

Coke: slightly puffed, laminate, vitreous.

Morrison's shaft coal, on J. B. Moss' land, section 8, township 11, range 6, near Centre Point, Clay county. Coal I, 3 feet 11 inches thick. This is a compact, strong, dull black, block coal in moderately thin laminæ, breaks into irregular cubic fragments; is slightly iron stained in the vertical seams.

	Top.	Middle.	Bottom.
Fixed Carbon	52.50	58.50	57.00
Gas,	37.00	34.00	36.00
Water	3.50	3.00	3.50
Ash ....flesh,	7.00	white, 4.50	flesh, 3.50
Coke	59.50	63.00	60.50
Heat units	7637.	7846.	7909.
Specific gravity	1.233	1.253	1.209
Weight of 1 cubic foot	77.06	78.31	75.56

Coke: from top and middle, laminate, vitreous, not puffed; from bottom, slightly puffed, amorphous, vitreous.

Muir & Free's coal, on section 27, township 9, range 7, in Clay county. Coal I, 3 feet 3 inches thick. This is a dull black, block coal with charcoal partings in moderately thin laminæ, breaks into irregular cubic forms and is glossy on the cross fracture.

	Top.	Middle.
Fixed Carbon	52.00	48.50
Gas	42.50	41.50
Water	2.50	4.00
Ash, white	3.00	6.00
Coke	55.00	54.50

Heat units	8101.	7727.
Specific gravity	1.269	1.167
Weight of 1 cubic foot	79.31	72.93

Coke: slightly puffed, laminate, lustreless.

Ward & Perry's coal, "Oakland Slope," on section 19, township 12, range 6, Clay county. Coal I, 4 feet thick. The top part of this coal is a dead black, compact, bony, cannel-like coal, with pyrites in the vertical seams. The remainder of the seam is a dull black, distinctly laminate, block coal with no appearance of pyrites.

	Top.	Middle.	Bottom.
Fixed carbon	57.00	58.50	58.00
Gas	36.50	36.00	34.50
Water	3.00	2.50	2.50
Ash	red, 3.50	white, 3.00	white, 5.00
Coke	60.50	61.50	63.00
Heat units	7955.	8030.	7851.
Specific gravity	1.165	1.162	1.222
Weight of 1 cubic foot	72.81	72.62	76.37

Coke: from top, not puffed, amorphous, brilliant; from middle and bottom, slightly puffed, laminate, vitreous.

Ambrose Phipp's coal, on section 30, township 10, range 6, near Middlebury, Clay county. Coal K, 3 feet thick. This is a brilliant black, semi-block coal in moderately thick laminæ, with charcoal partings, running into a caking coal at bottom of the seam, with pyrites. The whole is much iron-stained.

	Top.	Middle.	Bottom.
Fixed carbon	52.00	48.50	40.00
Gas	39.50	44.50	47.00
Water	3.00	2.50	2.50
Ash	brown, 5.50	pink, 4.50	red, 10.50
Coke	57.50	53.00	50.50
Heat units	7826.	8002.	7544.
Specific gravity	1.303	1.266	1.333
Weight of 1 cubic foot	81.43	79.15	83.31

Coke: slightly puffed, lustreless, laminate.

Jacob Rousch's coal, on section 4, township 9, range 6, near Middlebury, Clay county. Coal K, 17 inches thick. This

is a lustreless, black, slaty, block coal, in thin and easily separated laminæ; stained with iron in the vertical seams.

Fixed carbon	49.50
Gas	40.00
Water	3.50
Ash, flesh	7.00
Coke	56.50
Heat units	7670.
Specific gravity	1.239
Weight of 1 cubic foot	77.42

Coke: not puffed, lustreless, laminate.

Stedman's coal, near Centre Point, Clay county. Coal I, 3 feet 10 inches thick. A dull black, laminate, block coal, breaks into rectangular forms and shows some pyrites in the seams.

	Top.	Middle.	Bottom.
Fixed carbon	57.50	50.50	60.00
Gas	35.50	39.50	32.00
Water	3.00	2.00	3.00
Ash, white	4.00	8.00	5.00
Coke	61.50	58.50	65.00
Heat units	7903.	7904.	7784.
Specific gravity	1.208	1.216	1.220
Weight of 1 cubic foot	75.50	76.00	76.25

Coke: from top and middle, not puffed, laminate, lustreless; bottom, puffed, vitreous, amorphous.

John Storm's coal, on section 6, township 9, range 6, near Middlebury, Clay county. Coal B? 3 feet 6 inches thick. The upper part is a laminate, shaly, iron-stained, block coal; the middle and lower parts run into bright caking coal with white clay in the seams and breaks into irregular fragments.

	Top.	Middle.	Bottom.
Fixed carbon	52.50	59.00	55.50
Gas	38.00	36.00	35.50
Water	2.50	2.50	2.00
Ash, white	7.00	2.50	7.00
Coke	59.50	61.50	62.50
Heat units	7728.	8070.	7731.
Specific gravity	1.204	1.257	1.230
Weight of 1 cubic foot	75.25	78.56	76.87

Coke: from top not puffed, laminate, vitreous; from middle and bottom puffed, vitreous, amorphous.

Wagstaff's coal, near Coal City, Clay county. Coal B? 3 feet 6 inches thick. The top and bottom parts of this seam are lustreless, shaly, block coals, while the middle portion is a bright, glossy black, caking coal; the top portion contains considerable pyrites.

	Top.	Middle.	Bottom.
Fixed carbon	61.00	59.00	54.50
Gas	33.50	36 00	40.50
Water	2.50	2.50	2.50
Ash, red	3.00	2.50	2.50
Coke	64.00	61.50	57.00
Heat units	8003.	8070.	8120.
Specific gravity	1.319	1.231	1.214
Weight of 1 cubic foot	82.43	76.93	75.87

Coke: from top and bottom, not puffed, laminate, lustreless; from middle, puffed, amorphous, brilliant.

Woodruff & Fletcher's coal near Hoosiertown, Clay county. Coal I, 4 feet thick. This is a dull black, laminate, block coal, with charcoal partings, breaks into rhomboidal blocks, no visible pyrites.

	Top.	Middle.	Bottom.
Fixed carbon	55.50	59.00	58.00
Gas	36.00	35.50	38.50
Water	2.00	2.00	2.00
Ash	white, 6.50	flesh, 8.50	white, 1.50
Coke	62.00	62.50	59.50
Heat units	7787.	8024.	8218.
Specific gravity	1.221	1.216	1.188
Weight of 1 cubic foot	76.31	76.00	74.12

Coke: puffed, vitreous, amorphous.

OWEN COUNTY COALS.

Arney's coal, near Middletown, Owen county. Seam 3 feet 8 inches thick. This is a dull black, caking coal, breaking into irregular blocks, except a few inches of the middle of the seam, which has a conchoidal fracture, slightly iridescent and indistinctly laminate. In the upper and lower parts of the seam the laminæ are well marked and calcite appears in the vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	49.50	49.50	51.50
Gas	45.00	45.00	40.50

Water	3.00	3.50	3.00
Ash white,	2.50	white, 2.00	red, 5.00
Coke	52.00	51.50	56.50
Heat units	8129.	8129.	7877.
Specific gravity	1.212	1.206	1.271
Weight of 1 cubic foot	75.75	75.37	79.44

Coke: from top and middle, puffed, vitreous, amorphous; from bottom, not puffed, laminate, lustreless.

Reuben Barton's coal, on section 14, township 9, range 5, near Patricksburg, Owen county. Seam 17 inches thick. A glossy, black, caking coal, with pyrites in the partings; breaks into irregular cubes.

Fixed carbon	44.00
Gas	49.00
Water	2.50
Ash, red	4.50
Coke	48.50
Heat units	8051.
Specific gravity	1.267
Weight of 1 cubic foot	79.18

Coke: puffed, amorphous, brilliant.

James Beamen's coal, on section 3, township 11, range 4, near Cataract, Owen county. Coal A, 2 feet thick. This is a dull black, dry, block coal, in very thin laminæ; no signs of pyrites or calcite.

Fixed carbon	52.50
Gas	41.00
Water	3.50
Ash, red	3.00
Coke	55.50
Heat units	8004.
Specific gravity	1.240
Weight of 1 cubic foot	77.50

Coke: unaltered, laminate, vitreous.

Joseph Brammer's coal, on section 1, township 10, range 5, near Patricksburg, Owen county. Seam 32 inches thick. This is a dull black, semi-cannel coal with a slightly conchoidal fracture, the bottom of the seam running into slaty, block coal with pyrites in the partings; the whole showing iron stains.

	Top.	Middle.	Bottom.
Fixed carbon	46.00	53.50	46.00
Gas	48.50	41.00	47.00
Water	4.00	2.00	2.50
Ash	yellow, 1.50	red, 3.50	pink, 4.50
Coke	47.50	57.00	50.50
Heat units	8167.	8085.	8029.
Specific gravity	1.192	1.204	1.277
Weight of 1 cubic foot	74.50	75.25	79.81

Coke: from the cannel portion of the seam, shriveled, laminate, lustreless; that from the middle and bottom, slightly puffed, laminate, lustreless.

Tice Burger's coal, on section 26, township 10, range 6, near Marion, Owen county. This is a dull black, lustreless, block coal in thin laminæ with charcoal partings; pyrites occur in the vertical seams.

	Middle.	Bottom.
Fixed carbon	54.00	58.00
Gas	42.50	35.00
Water	2.00	3.50
Ash, white	1.50	3.50
Coke	55.50	61.50
Heat units	8262.	7897.
Specific gravity	1.191	1.223
Weight of 1 cubic foot	75.68	76.44

Coke: from middle part, not puffed, laminate, vitreous; from bottom, slightly puffed, vitreous, amorphous.

Chambers' coal, on section 3, township 10, range 5, near Patricksburg, Owen county. This is a jet black, brittle, caking coal in the top and middle portions of the seam, while the bottom part is slaty with considerable pyrites. The whole more or less stained with iron in the vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	49.00	56.50	50.00
Gas	45.50	39 00	39.00
Water	2.50	2.50	2.50
Ash	brown, 3.00	white, 2.00	brown, 8.50
Coke	52.00	58.50	58.50
Heat units	8134.	8143.	7618.
Specific gravity	1.230	1.237	1.248
Weight of 1 cubic foot	76.87	77.31	78.00

Coke: from top, slightly puffed, laminate, lustreless; from middle and bottom, unchanged, laminate, vitreous.

D. C. Cress' coal, near Vandalia, Owen county. Coal A, 2 feet 3 inches thick. This is a dull black, slaty, caking coal, with pyrites in the partings.

Fixed carbon	55.00
Gas	39.50
Water	3.00
Ash, yellow	2.50
Coke	57.50
Heat units	8068.
Specific gravity	1.248
Weight of 1 cubic foot	78.00

Coke: slightly puffed, vitreous, laminate.

G. Croft's coal, on section 23, township 10, range 6, near Marion, Owen county. Coal I, 3 feet thick. This is a dry, laminate, block coal, with charcoal partings, no pyrites visible.

	Middle.	Bottom.
Fixed carbon	57.50	57.00
Gas	38.50	36.00
Water	2.00	2.50
Ash, white	2.00	4.50
Coke	59.50	61.50
Heat units	8178.	7909.
Specific gravity	1.214	1.250
Weight of 1 cubic foot	75.87	78.12

Coke: slightly puffed, laminate, vitreous.

Joel Dillon's coal, on section 21, township 9, range 5, Owen county. Coal M, 18 inches thick. This is a slaty, dull black, block coal, stained with iron.

Fixed carbon	53.00
Gas	39.50
Water	3.00
Ash, white	4.50
Coke	57.50
Heat units	7906.
Specific gravity	1.243
Weight of 1 cubic foot	77.68

Coke: slightly puffed, laminate, vitreous.

Aaron Fiscus' coal, on section 26, township 9, range 5, in Owen county. Coal 14 inches thick. This is a compact,

slaty, dull black, cannel coal with pyrites and plant impressions in the partings.

Fixed carbon	45.00
Gas	33.00
Water	2.50
Ash, gray	19.50
Coke	64.50
Heat units	6664.
Specific gravity	1.362
Weight of 1 cubic foot	85.12

Coke: unchanged, laminate, vitreous.

Calvin Fletcher's coal, on section 10, township 10, range 5, near Patricksburg, Owen county. Coal I, 5 feet 6 inches thick. This is a dull black, laminate, block coal with charcoal partings, no visible pyrites, though stained with iron in vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	60.00	58.00	44.00
Gas	35.00	37.50	45.50
Water	2.00	2.00	2.00
Ash	white, 3.00	white, 2.50	red, 8.50
Coke	63.00	60.50	52.50
Heat units	8059.	8126.	7638.
Specific gravity	1.219	1.206	1.241
Weight of 1 cubic foot	76.18	75.37	77.56

Coke : slightly puffed, laminate, lustreless.

Louisa Hester's coal, on section 26, township 9, range 5, in Owen county. Coal 14 inches thick. A compact, slaty, dull black, cannel coal, with pyrites in the partings.

Fixed carbon	47.00
Gas	36.00
Water	4.50
Ash, gray	12.50
Coke	59.50
Heat units	7101.
Specific gravity	1.333
Weight of 1 cubic foot	83.31

Coke: unchanged, laminate, vitreous.

Jackson James' coal, near Arcola, Owen county. Coal A, 8 inches thick. This is a compact, lustreless, deep black, cannel coal.

Fixed carbon	32.50
Gas	54.00
Water	4.00
Ash, pink	9.50
Coke	42.00
Heat units	7580.
Specific gravity	1.222
Weight of 1 cubic foot	76.31

Coke: shrivelled, laminate, lustreless.

McCreary's coal, Owen county. Coal A, 1 foot 2 inches thick. This is a dull black, laminate, somewhat slaty, semi-block coal, with iron stains and pyrites in the vertical seams.

	Top.	Bottom.
Fixed carbon	53.50	51.00
Gas	38.00	42.00
Water	3.00	2.50
Ash, brown,	5.50	red, 4.50
Coke	59.00	59.50
Heat units	7809.	7974.
Specific gravity	1.280	1.276
Weight of 1 cubic foot	80.00	79.76

Coke: slightly puffed, laminate, lustreless.

W. S. Norris' coal, near Patricksburg, Owen county. Coal B, 2 feet 6 inches thick. This is a dull black, shaly, caking coal, with pyrites in the partings.

Fixed carbon	45.00
Gas	48.00
Water	2.00
Ash, red	5.00
Coke	50.00
Heat units	8040.
Specific gravity	1.282
Weight of 1 cubic foot	80.12

Coke: puffed, vitreous, amorphous.

Overholtzer's coal near Patricksburg, Owen county. Coal I, 4 to 6 feet thick. This is a dry, laminate, dull black, block coal, with charcoal partings, vertical seams stained with iron.

	Middle.	Bottom.
Fixed carbon	57.00	53.00
Gas	35.00	34.50
Water	3.50	3.00

Ash	yellow, 4.50	white, 9.50
Coke	61.50	62.50
Heat units	7817.	7447.
Specific gravity	1.242	1.292
Weight of 1 cubic foot	76.65	80.75

Coke: not puffed, laminate, lustreless.

Jesse Reagan's coal, near Stockton, Owen county. Seam 3 feet 6 inches thick. This is a dull black, dry, shaly, laminate, block coal, running into caking coal at bottom of seam; charcoal partings between the laminæ; vertical seams stained with iron.

	Top.	Middle.	Bottom.
Fixed carbon	52.50	52.00	52.50
Gas	37.00	40.50	39.50
Water	3.00	2.50	2.50
Ash, white	7.50	5.00	5.50
Coke	60.00	57.00	58.00
Heat units	7555.	7918.	7866.
Specific gravity	1.261	1.230	1.250
Weight of 1 cubic foot	78.81	76.87	78.12

Coke: slightly puffed, laminate, vitreous.

Jesse Rowe's coal, on section 11, township 10, range 6, near Marion, Owen county. Coal I, 3 feet 2 inches thick.

This is a dull black, slaty, laminate, semi-block coal, with pyrites in the partings.

	Middle.	Bottom.
Fixed carbon	56.00	53.50
Gas	36.00	39.00
Water	3.00	3.00
Ash, white	5.00	4.50
Coke	61.00	58.00
Heat units	7828.	7901.
Specific gravity	1.235	1.213
Weight of 1 cubic foot	77.18	75.81

Coke: not puffed, laminate, lustreless.

William Royer's coal, on section 11, township 10, range 5, near Patricksburg, Owen county. Coal I, 6 feet thick. This is a deep black, laminate, block coal, with charcoal in the partings. Some pyrites in the lower part of the seam.

	Top.	Middle.	Bottom.
Fixed carbon	55.50	55.00	51.50
Gas	38.00	39.00	41.50
Water	2.50	3.00	3.00

Ash .... white,	4.00	pink, 3.00	white, 4.00
Coke..........................	59.50	58.00	55.50
Heat units....................	7970.	8022.	7969.
Specific gravity............	1.260	1.193	1.219
Weight of 1 cubic foot	78.75	74.56	76.18

Coke: from top and middle, not puffed, amorphous, lustreless; from bottom, slightly puffed, amorphous, vitreous.

John C. Stahl's coal, on section 19, township 10, range 5, near Patricksburg, Owen county. Coal I, 4 feet 6 inches thick. This is a deep black, laminate, block coal, breaking in regular cubic forms, has charcoal partings, and the vertical seams are stained with iron.

Fixed carbon	58.00
Gas	36.00
Water	3.00
Ash, white..	3.00
Coke	61.00
Heat units..	7989.
Specific gravity..	1.203
Weight of one cubic foot..	75.18

Coke: not swollen, laminate, vitreous.

Mrs. R. White's coal, one mile south of Coal City, Owen county. Seam 2 feet 6 inches thick. A bright, black, laminate, semi-block coal, with iron stains and pyrites in the partings.

Fixed carbon..	55.50
Gas	39.00
Water..	3.00
Ash, pink..	2.50
Coke	58.00
Heat units	8062.
Specific gravity	1.216
Weight of one cubic foot..	76.00

Coke: not puffed, laminate, lustreless.

GREENE COUNTY.

B. Schweitzer's coal, on section 14, township 8, range 5, in Greene county. Coal A, 2 feet 6 inches thick. A bright black, caking coal, in indistinct laminæ, breaks into

regular cubes and has pyrites and iron stains in the vertical seams.

	Top.	Bottom.
Fixed carbon	47.00	50.00
Gas	44.50	44.00
Water	2.50	2.50
Ash, red	6.00	3.50
Coke	53.00	53.50
Heat units	7881.	8077.
Specfic gravity	1 317	1,302
Weight of 1 cubic foot	82.31	81.37

Coke: puffed, lustreless, amorphous.

FOUNTAIN COUNTY.

Barker's Mine, Fountain county. Block coal in thin, alternating, vitreous and lustreless laminæ, with charcoal partings, very hard and difficult to break across the bedding lines.

Fixed carbon	54.50
Gas	36.00
Water	5.00
Ash, white	4.50
Coke	59.00
Heat units	7707.
Specific gravity	1.195
Weight of 1 cubic foot	74.68

Coke: laminate, compact, lustreless.

Judge Coate's mine, Fountain county. A brilliant, glossy black, caking coal, indistinctly laminate, breaks with somewhat conchoidal fracture and contains pyrites in the partings.

Fixed carbon	47.50
Gas	44.00
Water	5.50
Ash, white	3.00
Coke	50.50
Heat units	7875.
Specific gravity	1.230
Weight of 1 cubic foot	76.25

Coke: puffed, glossy, amorphous.

Kirtland's mine, three miles north of Veedersburg, Fountain county. The top of the seam is a vitreous, compact,

caking coal, cubical fracture, distinctly laminate. The bottom of the seam is a dull, lustreless, cannel coal, breaks with a splinty fracture and contains pyrites and calcite in the vertical seams.

	Top.	Bottom.
Fixed carbon	47.50	39.00
Gas	46.00	53.00
Water	4.00	3.50
Ash red,	2.50	brown, 4.50
Coke	50.00	43.50
Heat units	8058.	8014.
Specific gravity	1.203	1.211
Weight of 1 cubic foot	75.18	75.68

Coke: from top coal, slightly altered, compact, vitreous; from bottom coal, unaltered, lustreless.

James W. McKee's coal, Fountain county. A compact, dull black, block coal, with occasional quarter-inch strata of brilliant, cubical, caking coal, separated by thin laminæ, and they in turn by fibrous charcoal markings, vertical seams slightly stained with iron.

	Top.	Bottom.
Fixed carbon	55.00	47.50
Gas	35.00	41.50
Water	6.00	5.50
Ash, white	4.00	5.50
Coke	59.00	53.00
Heat units	7655.	7644.
Specific gravity	1.205	1.225
Weight of 1 cubic foot	75.31	76.56

Coke : compact, unaltered, laminate, vitreous.

Stedman Thompson's coal, Fountain county. This is a deep black, lustreless, compact, block coal, in thin laminæ, very strong, and free from pyrites.

	Top.	Bottom.
Fixed carbon	52.50	51.50
Gas	37.50	41.50
Water	5.50	3.00
Ash white,	4.50	flesh, 4.00
Coke	57.00	55.50
Heat units	7682.	7969.
Specific gravity	1.239	1.207
Weight of 1 cubic foot	77.43	75.43

Coke: unchanged, compact, vitreous, laminate.

VANDERBURG COUNTY.

Ingleside mine, near Evansville. Coal M, 4 feet 2 inches thick. This is a glossy black, caking coal, irregular fracture, with calcite in the vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	44.00	48.50	46 00
Gas	39.50	42.00	39.50
Water	3.00	3.50	3.50
Ash, white	13.50	6.00	11.00
Coke	57.50	54.50	57.50
Heat units	7179.	7772.	7341.
Specific gravity	1.273	1.275	1.336
Weight of 1 cubic foot	79.56	79.68	83 50

Coke: puffed, amorphous, brilliant.

Ingleside mine, John Engle's heirs, near Evansville, Vanderburg county. Lower coal L, 1 foot 3 inches thick. This is a dull black, caking coal, with charcoal markings between the laminæ; pyrites and calcite are seen in the vertical seams, which are more or less stained with iron.

Fixed carbon	53.50
Gas	39.00
Water	3.50
Ash, red	4.00
Coke	57.50
Heat units	7901.
Specific gravity	1.275
Weight of 1 cubic foot	79.68

Coke: puffed, lustreless, amorphous.

WARRICK COUNTY.

Chandler's coal, 12 miles east of Evansville, in Warrick county. Coal M, 4 feet 2 inches thick. This is a jet black, semi-block coal, with charcoal markings between the laminæ; breaks into cubic forms and shows some pyrites and considerable calcite in the vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	47.50	49.50	45.00
Gas	40.00	41.50	34.50
Water	3.50	3.50	4.00
Ash, white	9.00	5.50	16.50

Coke	56.50	55.00	61.00
Heat units	7508.	7808.	6801.
Specific gravity	1 274	1.282	1.283
Weight of 1 cubic foot	79.62	80.12	80.18

Coke: from top and middle, slightly puffed, laminate, lustreless; from bottom, less puffed, lustreless, amorphous.

Millersburg coal, Warrick county. Coal N, 3 feet 6 inches thick. A dense, glossy black, caking coal, conchoidal fracture, with occasional iridescence, no pyrites visible.

	Middle.	Bottom.
Fixed carbon	53.00	49.00
Gas	41.50	45.50
Water	3.00	3.50
Ash	blue, 2.50	brown, 2.00
Coke	55.50	51.00
Heat units	8090.	8042.
Specific gravity	1.242	1.243
Weight of 1 cubic foot	77.62	77.68

Coke: slightly puffed, lustreless, amorphous.

POSEY COUNTY.

George Heldferl's coal, near St. Wendells, Posey county. Seam 18 inches thick. This is a dull black, slaty, caking coal, stained with iron in the seams.

Fixed carbon	51.00
Gas	39.50
Water	4.00
Ash, brown	5.50
Coke	56.50
Heat units	7745.
Specific gravity	1.327
Weight of 1 cubic foot	82.93

Coke: not puffed, laminate, lustreless.

SULLIVAN COUNTY.

Dick's mine, on section 30, township 9, range 8, Sullivan county. Coal M. Upper part of seam, collected by Prof. Collett in 1870. A brilliant, glossy black, caking coal, irregular fracture, no visible laminæ, has the appearance of bitumen after being melted and cooled; contains very little earthy matter. The first column gives the analysis made in

December, 1870. The second column, the analysis after the specimen had been kept in the laboratory five years.

	Analysis of 1870.	Analysis of 1875.
Fixed carbon	50.50	55.00
Gas	43.50	40.00
Water	4.50	3.50
Ash, white	1.50	1.50
Coke	52.00	56.50
Heat units	8071.	8114.
Specific gravity	1.239	1.258
Weight of 1 cubic foot	77.43	78.62

Coke: in both cases, has a metallic lustre, slightly puffed, amorphous, compact.

DAVIESS COUNTY.

James S. Morgan's coal, on the Ohio and Mississippi railroad in Daviess county. No. 1 is the top and No. 2 the bottom of the top seam of coal 30 feet from the surface. The top of the seam is a deep black, distinctly laminate, block coal with charcoal partings, breaks into irregular cubes and shows pyrites in the seams. The bottom of the seam is a bright, deep black, semi-block coal with no traces of pyrites. No. 3, is a lower seam, 63 feet from the surface, 3 feet 4 inches thick, a glossy, jet black, caking coal, conchoidal fracture, laminæ not distinct, no pyrites visible.

	No. 1.		No. 2.		No. 3.
Fixed carbon	56.00		53.50		53.00
Gas	32.50		36.00		39.50
Water	6.00		5.50		5.00
Ash red,	5.50	white,	5.00	white,	2 50
Coke	61.50		58.50		55.50
Heat units	7507.		7626.		7906.
Specific gravity	1.277		1.252		1.239
Weight of 1 cubic foot	79.81		78.25		77.44

Coke: from No's. 1 and 2, slightly puffed, laminate, lustreless; from No. 3, much puffed, vitreous, amorphous.

VERMILLION COUNTY.

Charles Moore's coal, near State line, on Indianapolis, Decatur & Springfield Railroad, in Vermillion county. Seam 4 feet 6 inches thick, 130 feet from the surface.

This is a deep black, caking coal, distinct laminæ, breaks into large cubical blocks and has some pyrites and calcite in the vertical seams.

Fixed carbon	46.00
Gas	44.00
Water	5.50
Ash, flesh	4.50
Coke	50.50
Heat units	7754.
Specific gravity	1.258
Weight of 1 cubic foot	78.62

Coke: puffed, amorphous, lustreless.

PARKE COUNTY.

Hargrave's mine, north side of Sugar creek, near Moore's Mill, Parke county. A glossy, deep black, caking coal, upper part shaly, with pyrites in the seams.

Fixed carbon	46.50
Gas	46.00
Water	4.00
Ash, brown	3.50
Coke	50.50
Heat units	7977.
Specific gravity	1.228
Weight of 1 cubic foot	76.75

Coke: puffed, amorphous, brilliant.

MONTGOMERY COUNTY.

Berryman Clover's coal, four miles south of Waveland, Montgomery county. Coal A, 1 foot thick. A dull black, caking coal in indistinct laminæ, stained with iron and has considerable pyrites in the partings.

Fixed carbon	52.00
Gas	41.50
Water	3.00
Ash, white	3.50
Coke	55.50
Heat units	8010.
Specific gravity	1.254
Weight of 1 cubic foot	78.37

Coke: slightly puffed, laminate, lustreless.

Hannah S. Burford's coal, three and a half miles northwest of Waveland, Montgomery county. Coal A, 7 inches thick. A dull black, caking coal, in thin laminæ, with pyrites in the partings.

Fixed carbon	49.00
Gas	43.50
Water	2.50
Ash, white	5.00
Coke	54.00
Heat units	7950.
Specific gravity	1.202
Weight of 1 cubic foot	75.12

Coke: puffed, laminate, lustreless.

EXTRA-LIMITAL COALS.

Connellsville coal, Fayette county, Pennsylvania. Sent by E. C. Pechin, of Dunbar Furnace, in the autumn of 1875. From this coal the celebrated foundry coke is made. The specimen received would measure about one-half a cubic foot; every part of it displayed prismatic colors; it has a columnar structure, inclined to be granular and easily broken into small fragments.

Fixed carbon	65.00
Gas	24.00
Water	4.50
Ash, white	6.50
Coke	71.50
Heat units	7454.
Specific gravity	1.280
Weight of 1 cubic foot	80.00

Coke: of steel gray color, columnar, very strong, dense, slightly puffed on the surface.

Stone's Gas coal, Fayette county, Pennsylvania. This coal is in common use in many cities in the western states for the manufacture of illuminating gas. The specimen analysed was obtained at the Indianapolis Gas Works, and said by the Superintendent to be "first-class."

Fixed carbon	58.00
Gas	34.00
Water	3.00

Ash, white	5.00
Coke	63.00
Heat units	7805.
Specific gravity	1.292
Weight of 1 cubic foot	80.75

Coke: slightly puffed, amorphous, lustreless, and is much esteemed by our citizens as a grate and stove fuel.

Coal from Sardrie, Mud river, Mecklenburg county, Kentucky. Coal N, (No. 11, of D. D. Owen), 3 feet 6 inches thick. This is a dull black, vitreous, caking coal, with irregular, resinous fracture, laminæ indistinct, no visible pyrites.

	Sardrie.	Mud river.
Fixed carbon	51.00	57.00
Gas	42.50	37.00
Water	2.00	3.50
Ash, white	4.50	2.50
Coke	55.50	59.50
Heat units	8020.	8000.
Specific gravity	1.325	1.280
Weight of 1 cubic foot	82.81	80.00

Coke: puffed, lustreless, amorphous.

Wilmington coal, Illinois. A brilliant, jet black, caking coal, cubical fracture, with pyrites and calcite in the seams.

Fixed carbon	46.00
Gas	37.00
Water	10.50
Ash, red	6.50
Coke	52.50
Heat units	7111.
Specific gravity	1.248
Weight of 1 cubic foot	78.00

Coke: puffed, amorphous, brilliant.

Monunk coal, Illinois. A campact, deep black, caking coal, laminæ very indistinct, breaks into irregular cubes, and contains some pyrites.

Fixed carbon	48.00
Gas	35.00
Water	11.50
Ash, brown	5.50
Coke	53.50

Heat units	7089.
Specific gravity	1.232
Weight of 1 cubic foot	77.00

Coke: puffed, lustreless, amorphous.

Lignite—Brown coal, from Robertson county, Texas. Seam 10 feet thick, specimen presented by Levi Pennington. This is a lustreless, dull brown coal with irregular fracture, and much inclined to shrink, crack and fall to pieces on exposure to the air.

Fixed carbon	45,00
Gas	39.50
Water	11.00
Ash, white	4.50
Coke	49.50
Heat units	7260.
Specific gravity	1.232
Weight of 1 cubic foot	77.00

Coke: slightly shrunken, lustreless, and bears a close resemblance to wood charcoal.

ANALYSES OF COALS—CLAY COUNTY.

County.	Name of Mine or Owner.	Specific gravity.	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total Volatile Matter.	Heat Units.	Color of Ash.
Clay	Elias Cooprider, Middlebury, top	1,280	80.00	44.00	4.50	48,50	47,50	4,00	51.50	7994.	Pink.
Clay	Elias Cooprider, Middlebury, middle	1.533	95,81	45.00	8.50	53.50	44,00	2 50	46,50	7673.	Brown.
Clay	Elias Cooprider, Middlebury, bottom	1.211	75.68	50.50	4.00	54.50	42.50	3,00	45.50	7980.	Yellow.
Clay	John Cooprider, Middlebury, middle	1,271	79,44	44.50	5,50	50.00	47.00	3.00	50.00	7808.	Purple.
Clay	John Cooprider, Middlebury, bottom	1.274	79.62	41,50	7.50	49.00	47.50	3.50	51.00	7711.	Purple.
Clay	Kennedy, Centre Point, top	1.354	84.62	46.50	15.50	62.00	35,00	3.00	38,00	6968,	Brown.
Clay	Kennedy, Centre Point, middle	1.204	75.25	49.50	9,00	58.50	39,00	2.50	41,50	7575.	White.
Clay	Kennedy, Centre Point, bottom	1,188	74.25	52,00	4,50	56,50	40,50	3,00	43,50	7917.	White.
Clay	Knickerbocker Coal Co., Salem, top	1.167	72.93	55 00	5.50	60.50	37.00	2.50	39.50	7838.	Buff.
Clay	Knickerbocker Coal Co., Salem, middle	1.184	74.00	52.50	6.00	58.50	39,50	2,00	41,50	7774,	White,
Clay	Knickerbocker Coal Co., Salem, bottom	1.241	77.56	50.50	6,50	57,00	40,00	3,00	43.00	7750.	White.
Clay	W. R. Kress, Middlebury, top	1.318	82.37	44.00	13,00	57.00	39,50	3.50	43,00	7179.	Red.
Clay	W. R. Kress, Middlebury, middle	1,287	80.43	40.50	10.50	51.00	44.50	4.50	49.00	7355,	Brown.
Clay	W. R. Kress, Middlebury, bottom	1.432	89,40	38.50	13.00	51.50	44,50	4.00	48.50	7194,	Gray.
Clay	Lim. Liability Coal Co., Ashville	1.231	76,93	57.00	3,00	60.00	37,00	3,00	40.00	8000,	White.
Clay	Coal from Lodi	1.308	81,43	43.00	13,50	56,50	40.50	3.00	43,50	7190.	Red.
Clay	Markland Coal Co., Clay City, top	1.202	75.12	58.00	4 00	62.00	36,00	2,00	38,00	7989,	White.
Clay	Markland Coal Co., Clay City, middle	1.145	71.56	63.50	0.50	64.00	33.50	2.50	36.00	8205.	White.
Clay	Markland Coal Co., Clay City, bottom	1.221	76.31	59.00	2.50	61,50	36,00	2.50	38.50	8070.	White.
Clay	Morrison's shaft, Centre Point, top	1,233	77,06	52,50	7,00	59.50	37.00	3.50	40,50	7637,	Flesh.
Clay	Morrison's shaft, Centre Point, middle	1.253	78.31	58,50	4,50	63.00	34.00	3.00	37.00	7846.	White.
Clay	Morrison's shaft, Centre Point, bottom	1,200	75.56	57.00	3.50	60,50	36.00	3,50	39.50	7909.	Flesh.

ANALYSES OF COALS—CLAY COUNTY.

County.	Name of Mine or Owner.	Specific Gravity	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water	Total Volatile Matter.	Heat Units.	Color of Ash.
Clay	Muir & Free, top	1.269	79.31	52.00	3.00	55.00	42.50	2.50	45.00	8101.	White.
Clay	Muir & Free, middle	1.167	72.93	48.50	6.00	54.50	41.50	4.00	45.50	7727.	White.
Clay	McClelland & Zeller	1.285	80.31	56.50	2.50	59.00	32.50	8.50	41.00	8005.	White.
Clay	John McCrea, Hoosiertown, top	1.196	74.75	56.50	2.00	58.50	39.50	2.00	41.50	8189.	White.
Clay	John McCrea, Hoosiertown, middle	1.229	76 81	56.00	5.50	61.50	36.00	2.50	38.50	7828.	White.
Clay	John McCrea, Hoosiertown, bottom	1.227	76.06	58.00	2.50	60.50	37.00	2.50	39.50	8080.	White.
Clay	Niblock & Co.'s "Chicago Mine,"	1.251	78.19	50.50	2.00	52.50	41.50	6 00	47.50	7888.	White.
Clay	A. Phipps, Middlebury, top	1.303	81.43	52.00	5.50	57.50	39.50	3.00	42.50	7826.	Brown.
Clay	A. Phipps, Middlebury, middle	1.266	79 15	48.50	4.50	53.00	44.50	2.50	47.00	8002.	Pink.
Clay	A. Phipps, Middlebury, bottom	1.333	83.31	40.00	10 50	50.50	47.00	2.50	49.50	7514.	Red.
Clay	Jacob Roush, Middlebury	1.239	77.42	49.50	7.00	56.50	40.00	3.50	43.50	7670.	Flesh.
Clay	Stedman's, Centre Point, top	1.208	75.50	57.50	4.00	61.50	35.50	3.00	38.50	7903.	White.
Clay	Stedman's, Centre Point, middle	1.216	76.00	50.50	8.00	58.50	39.50	2.00	41.50	7904.	White.
Clay	Stedman's, Centre Point, bottom	1.220	76.25	60.00	5.00	65.00	32.00	3.00	35.00	7784.	White.
Clay	J. Storm, Middlebury, top	1.204	75.25	52 50	7.00	59.50	38.00	2.50	40.50	7728.	White.
Clay	J. Storm, Middlebury, middle	1.257	78.56	59.00	2.50	61.50	36.00	2.50	38.50	8070.	White.
Clay	J. Storm, Middlebury, bottom	1.230	76.87	55.50	7.00	62.50	35.50	2.00	37.50	7731.	White.
Clay	Wagstaff, Clay City, top	1.319	82.43	61.00	3.00	64.00	33.50	2.50	36.00	8003.	Red.
Clay	Wagstaff, Clay City, middle	1.231	76.93	59.00	2.50	61.50	36.00	2.50	38.50	8070.	Pink.
Clay	Wagstaff, Clay City, bottom	1.214	75.87	54.50	2.50	57.00	40.50	2.50	43.00	8120.	Pink.
Clay	Ward & Perry, Oakland Slope, top	1.165	72.81	57.00	3.50	60.50	36.50	3.00	39.50	7955.	Red.
Clay	Ward & Perry, Oakland Slope, middle	1.162	72.62	58.50	3.00	61.50	36 00	2.50	38.50	8030.	White.
Clay	Ward & Perry, Oakland Slope, bottom	1,222	76.37	58.00	5.00	63.00	34,50	2.50	37,00	7851.	White,

ANALYSES OF COALS—CLAY AND OWEN COUNTIES.

County.	Name of Mine or Owner.	Specific gravity.	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total volatile matter.	Heat units.	Color of Ash.
Clay	Woodruff & Fletcher, Hoosiertown, top	1.221	76.31	55.50	6.50	62.00	36.00	2.00	38.00	7787.	White.
Clay	Woodruff & Fletcher, Hoosiertown, middle	1.216	76.00	59.00	3.50	62.50	35.50	2.00	37.50	8024.	Flesh.
Clay	Woodruff & Fletcher, Hoosiertown, bottom	1.188	74.12	58.00	1.50	59.50	38.50	2.00	40.50	8218.	White.
Clay	Woodruff & Fletcher, near Brazil, old	1.142	71.87	59.00	1.50	60.50	35.50	4.00	39.50	8024.	White.
Owen	Arney's, top	1.212	75.75	49.50	2.50	52.00	45.00	3.00	48.00	8129.	White.
Owen	Arney's middle	1.206	75.37	49.50	2.00	51.50	45.00	3.50	48.50	8120.	White.
Owen	Arney's bottom	1.271	79.44	51.50	5.00	56.50	40.50	3.00	43.50	7877.	Red.
Owen	Reuben Barton	1.267	79.18	44.00	4.50	48.50	49.00	2.50	51.50	8051.	Red.
Owen	James Beaman	1.240	77.50	52.50	3.00	55.50	41.00	3.50	44.50	8094.	Red.
Owen	James Brammer, Patricksburg, top	1.192	74.50	46.00	1.50	47.50	48.50	4.00	52.50	8167.	Yellow.
Owen	James Brammer, Patricksburg, middle	1.204	75.25	53.50	3.50	57.00	41.00	2.00	43.00	8085.	Red.
Owen	James Brammer, Patricksburg, bottom	1.277	79.81	46.00	4.50	50.50	47.00	2.50	49.50	8029.	Pink.
Owen	Tice Bunger, middle	1.191	75.68	54.00	1.50	55.50	42.50	2.00	44.50	8262.	White.
Owen	Tice Bunger, bottom	1.223	76.44	58.00	3.50	61.50	35.00	3.50	38.50	7897.	White.
Owen	Chambers, top	1.230	76.87	49.00	3 00	52.00	45.50	2.50	48.00	8134.	Brown.
Owen	Chambers, middle	1.237	77.31	56.50	2.00	58.50	39.00	2.50	41.50	8143.	White.
Owen	Chambers, bottom	1.248	78.00	50.00	8.50	58.50	39.00	2.50	41.50	7618.	Brown.
Owen	D. C. Cress	1.248	78.00	55.00	2.50	57.50	39.50	3.00	42.50	8068.	Yellow.
Owen	G. Croft, middle	1.214	75.87	57.50	2.00	59.50	38.50	2.00	40.50	8178.	White.
Owen	G. Croft, bottom	1.250	78.12	57.00	4.50	61.50	36.00	2.50	38.50	7909.	White.
Owen	Joel Dillon	1.243	77.63	53.00	4.50	57.50	39.50	3.00	42.50	7906.	White.
Owen	A. Fiscus	1.362	85.12	45.00	19.50	64.50	33.00	2.50	35.50	6664.	Gray.

ANALYSES OF COALS—OWEN AND GREENE COUNTIES.

County.	Name of Mine or Owner.	Specific Gravity	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total Volatile Matter.	Heat Units.	Color of Ash.
Owen	Calvin Fletcher, top	1.219	76.18	60.00	3.00	63.00	35.00	2.00	37.00	8059.	White.
Owen	Calvin Fletcher, middle	1.206	75.37	58.00	2.50	60.50	37.50	2.00	39.50	8126.	White.
Owen	Calvin Fletcher, bottom	1.241	77.56	44.00	8.50	52.50	45.50	2.00	47.50	7638.	Red.
Owen	Louisa Hester, cannel slate	1.333	83.31	47.00	12.50	59.50	36.00	4.50	40.50	7101.	Gray.
Owen	Jackson James	1.222	76.31	32.50	9.50	42.00	54.00	4.00	58.00	7580.	Pink.
Owen	McCreary, top	1.280	80.00	53.50	5.50	59.00	38.00	3.00	41.00	7809.	Brown.
Owen	McCreary, bottom	1.276	79.76	51.00	4.50	55.50	42.00	2.50	44.50	7974.	Red.
Owen	W. S. Norris	1.282	80.12	45.00	5.00	50.00	48.00	2.00	50.00	8040.	Red.
Owen	Oberholtzer, middle	1.242	77.62	57.00	4.50	61.50	35.00	3.50	38.50	7817.	Yellow.
Owen	Oberholtzer, bottom	1.292	80.75	53.00	9.50	62.50	34.50	3.00	37.50	7447.	White.
Owen	Jesse Reagan, top	1.261	78.81	52.50	7.50	60.00	37.00	3.00	40.00	7555.	White.
Owen	Jesse Reagan, middle	1.230	76.87	52.00	5.00	57.00	40.50	2.50	43.00	7918.	White.
Owen	Jesse Reagan, bottom	1.250	78.12	52.50	5.50	58.00	39.50	2.50	42.00	7866.	White.
Owen	J. Rowe, middle	1.235	77.18	56.00	5.00	61.00	36.00	3.00	39.00	7828.	White.
Owen	J. Rowe, bottom	1.213	75.81	53.50	4.50	58.00	39.00	3.00	42.00	7901.	White.
Owen	William Royer, top	1.260	78.75	55.50	4.00	59.50	38.00	2.50	40.50	7970.	White.
Owen	William Royer, middle	1.193	74.56	55.00	3.00	58.00	39.00	3.00	42.00	8022.	Pink.
Owen	William Royer, bottom	1.219	76.18	51.50	4.00	55.50	41.50	3.00	44.50	7969.	White.
Owen	J. C. Stall	1.203	75.18	58.00	3.00	61.00	36.00	3.00	39.00	7989.	White.
Owen	White	1.216	76.00	55.50	2.50	58.00	39.00	3.00	42.00	8062.	Pink.
Greene	B. Schweitzer, top	1.317	82.31	47.00	6.00	53.00	44.50	2.50	47.00	7881.	Red.
Greene	B. Schweitzer, bottom	1.302	81.37	50.00	3.50	53.50	44.00	2.50	46.50	8077.	Red.
Robertson	Brown coal, Texas	1.232	77.00	45.00	4.50	49.50	39.50	11.00	50.50	7260.	White.

ANALYSES OF COALS—CLAY AND OWEN COUNTIES.

County.	Name of Mine or Owner.	Specific gravity.	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total volatile matter.	Heat units.	Color of Ash.
Clay	Woodruff & Fletcher, Hoosiertown, top	1.221	76.31	55.50	6.50	62.00	36.00	2.00	38.00	7787.	White.
Clay	Woodruff & Fletcher, Hoosiertown, middle	1.216	76.00	59.00	3.50	62.50	35.50	2.00	37.50	8024.	Flesh.
Clay	Woodruff & Fletcher, Hoosiertown, bottom	1.188	74.12	58.00	1.50	59.50	38.50	2.00	40.50	8218.	White.
Clay	Woodruff & Fletcher, near Brazil, old	1.142	71.37	59.00	1.50	60.50	35.50	4.00	39.50	8024.	White.
Owen	Arney's, top	1.212	75.75	49.50	2.50	52.00	45.00	3.00	48.00	8129.	White.
Owen	Arney's middle	1.206	75.37	49.50	2.00	51.50	45.00	3.50	48.50	8120.	White.
Owen	Arney's bottom	1.271	79.44	51.50	5.00	56.50	40.50	3.00	43.50	7877.	Red.
Owen	Reuben Barton	1.267	79.18	44.00	4.50	48.50	49.00	2.50	51.50	8051.	Red.
Owen	James Beaman	1.240	77.50	52.50	3.00	55.50	41.00	3.50	44.50	8004.	Red.
Owen	James Brammer, Patricksburg, top	1.192	74.50	46.00	1.50	47.50	48.50	4.00	52.50	8167.	Yellow.
Owen	James Brammer, Patricksburg, middle	1.204	75.25	53.50	3.50	57.00	41.00	2.00	43.00	8085.	Red.
Owen	James Brammer, Patricksburg, bottom	1.277	79.81	46.00	4.50	50.50	47.00	2.50	49.50	8029.	Pink.
Owen	Tice Bunger, middle	1.191	75.68	54.00	1.50	55.50	42.50	2.00	44.50	8262.	White.
Owen	Tice Bunger, bottom	1.223	76.44	58.00	3.50	61.50	35.00	3.50	38.50	7897.	White.
Owen	Chambers, top	1.230	76.87	49.00	3.00	52.00	45.50	2.50	48.00	8134.	Brown.
Owen	Chambers, middle	1.237	77.31	56.50	2.00	58.50	39.00	2.50	41.50	8143.	White.
Owen	Chambers, bottom	1.248	78.00	50.00	8.50	58.50	39.00	2.50	41.50	7618.	Brown.
Owen	D. C. Cress	1.248	78.00	55.00	2.50	57.50	39.50	3.00	42.50	8068.	Yellow.
Owen	G. Croft, middle	1.214	75.87	57.50	2.00	59.50	38.50	2.00	40.50	8178.	White.
Owen	G. Croft, bottom	1.250	78.12	57.00	4.50	61.50	36.00	2.50	38.50	7909.	White.
Owen	Joel Dillon	1.243	77.68	53.00	4.50	57.50	39.50	3.00	42.50	7906.	White.
Owen	A. Fiscus	1.362	85.12	45.00	19.50	64.50	33.00	2.50	35.50	6664.	Gray.

ANALYSES OF COALS—OWEN AND GREENE COUNTIES.

County.	Name of Mine or Owner.	Specific Gravity	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total Volatile Matter.	Heat Units.	Color of Ash.
Owen	Calvin Fletcher, top	1.219	76.18	60.00	3.00	63.00	35.00	2.00	37.00	8059.	White.
Owen	Calvin Fletcher, middle	1.206	75.37	58.00	2.50	60.50	37.50	2.00	39.50	8126.	White.
Owen	Calvin Fletcher, bottom	1.241	77.56	44.00	8.50	52.50	45.50	2.00	47.50	7638.	Red.
Owen	Louisa Hester, cannel slate	1.333	83.31	47.00	12.50	59.50	36.00	4.50	40.50	7101.	Gray.
Owen	Jackson James	1.222	76.31	32.50	9.50	42.00	54.00	4.00	58.00	7580.	Pink.
Owen	McCreary, top	1.280	80.00	53.50	5.50	59.00	38.00	3.00	41.00	7809.	Brown.
Owen	McCreary, bottom	1.276	79.76	51.00	4.50	55.50	42.00	2.50	44.50	7974.	Red.
Owen	W. S. Norris	1.282	80.12	45.00	5.00	50.00	48.00	2.00	50.00	8040.	Red.
Owen	Oberholtzer, middle	1.242	77.62	57.00	4.50	61.50	35.00	3.50	38.50	7817.	Yellow.
Owen	Oberholtzer, bottom	1.292	80.75	53.00	9.50	62.50	34.50	3.00	37.50	7447.	White.
Owen	Jesse Reagan, top	1.261	78.81	52.50	7.50	60.00	37.00	3.00	40.00	7555.	White.
Owen	Jesse Reagan, middle	1.230	76.87	52.00	5.00	57.00	40.50	2.50	43.00	7918.	White.
Owen	Jesse Reagan, bottom	1.250	78.12	52.50	5.50	58.00	39.50	2.50	42.00	7866.	White.
Owen	J. Rowe, middle	1.235	77.18	56.00	5.00	61.00	36.00	3.00	39.00	7828.	White.
Owen	J. Rowe, bottom	1.213	75.81	53.50	4.50	58.00	39.00	3.00	42.00	7901.	White.
Owen	William Royer, top	1.260	78.75	55.50	4.00	59.50	38.00	2.50	40.50	7970.	White.
Owen	William Royer, middle	1.193	74.56	55.00	3.00	58.00	39.00	3.00	42.00	8022.	Pink.
Owen	William Royer, bottom	1.219	76.18	51.50	4.00	55.50	41.50	3.00	44.50	7969.	White.
Owen	J. C. Stall	1.203	75.18	58.00	3.00	61.00	36.00	3.00	39.00	7989.	White.
Owen	White	1.216	76.00	55.50	2.50	58.00	39.00	3.00	42.00	8062.	Pink.
Greene	B. Schweitzer, top	1.317	82.31	47.00	6.00	53.00	44.50	2.50	47.00	7881.	Red.
Greene	B. Schweitzer, bottom	1.302	81.37	50.00	3.50	53.50	44.00	2.50	46.50	8077.	Red.
Robertson	Brown coal, Texas	1.232	77.00	45.00	4.50	49.50	39.50	11.00	50.50	7260.	White.

ANALYSES OF COALS—VIGO AND FOUNTAIN COUNTIES.

County.	Name of Mine or Owner.	Specific gravity.	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water	Total volatile matter.	Heat units.	Color of Ash.
Vigo	Arbuckle & Budd, Seelyville, top	1.211	75.68	48.00	3.50	51.50	45.00	3.50	48.50	8007.	White.
Vigo	Arbuckle & Budd, Seelyville, bottom	1.250	78.12	50.00	3.50	53.50	43.50	3.00	46.50	8031.	White.
Vigo	Barrick & Sons	1.192	74.50	48.20	4.30	52.50	44.50	3.00	47.50	8000.	Red.
Vigo	Henry Brayton, Grant	1.216	76.00	44.00	8.50	52.50	44.00	3.50	47.50	7592.	Red.
Vigo	Foote's bore	1.217	76.06	50.10	1.80	51.90	44.40	3.70	48.10	8123.	Brown.
Vigo	P. H. Holloman	1.242	77.62	42.00	12.50	54.50	42.00	3.50	45.50	7247.	White.
Vigo	G. W. Mooreland	1.195	74.70	47.50	4.50	52.00	43.50	4.50	48.00	7829.	Red.
Vigo	A. McPherson	1.239	77.43	56.50	4.00	60.50	37.00	2.50	39.50	7950.	White.
Vigo	McQuilkins	1.210	75.62	47.50	3.50	51.00	44.50	4.50	49.00	7921.	White.
Vigo	F. Rhyan	1.228	76.62	48.50	6.00	54.50	43.50	2.00	45.50	7910.	Flesh.
Vigo	Somerset Coal Company	1.210	75.62	51.00	1.50	52.50	43.00	4.50	47.50	8066.	White.
Vigo	Webster & Bramwell, top	1.197	74.81	48.00	3.00	51.00	46.00	3.00	49.00	8098.	Purple.
Vigo	Webster & Bramwell, bottom	1.210	75.62	47.50	4.00	51.50	45.50	3.00	48.50	8013.	Red.
Vigo	J. S. Wyeth, Hartford, top	1.237	77.31	49.00	7.50	56.50	41.00	2.50	43.50	7721.	White.
Vigo	J. S. Wyeth, Hartford, bottom	1.216	76.00	51.00	4.50	55.50	42.00	2.50	44.50	7974.	White.
Fountain	Barker's	1.195	74.68	54.50	4.50	59.00	36.00	5.00	41.00	7707.	White.
Fountain	Judge Coates'	1.230	76.25	47.50	3.00	50.50	44.00	5.50	49.50	7875.	White.
Fountain	Kirtland, top	1.203	75.18	47.50	2.50	50.00	46.00	4.00	50.00	8058.	Red.
Fountain	Kirtland, bottom	1.211	75.68	39.00	4.50	43.50	53.00	3.50	56.50	8014.	Brown.
Fountain	J. W. McKee, top	1.205	75.31	55.00	4.00	59.00	35.00	6.00	41.00	7655.	White.
Fountain	J. W. McKee, bottom	1.225	76.56	47.50	5.50	53.00	41.50	5.50	47.00	7646.	White.
Fountain	Steadman Thompson, top	1.239	77.43	52.50	4.50	57.00	37.50	5.50	43.00	7682.	White.
Fountain	Steadman Thompson, bottom	1.207	75.43	51.50	4.00	55.50	41.50	3.00	44.50	7960.	Flesh.

ANALYSES OF COALS.

COUNTY.	NAME OF MINE OR OWNER.	Specific Gravity	Weight of one Cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total Volatile Matter.	Heat Units.	Color of Ash.
Vanderburg	Ingleside, (L)	1.275	79.68	53.50	4.00	57.50	39.00	3.50	42.50	7901.	Red.
Vanderburg	Ingleside, (M), top	1.273	79.56	44.00	13.50	57.50	39.50	3.00	42.50	7179.	White.
Vanderburg	Ingleside, (M), middle	1.275	79.68	48.50	6.00	54.50	42.00	3.50	45.50	7772.	White.
Vanderburg	Insleside, (M), bottom	1.336	83.50	46.00	11.00	57.00	39.50	3.50	43.00	7341.	White.
Warrick	Chandler's, (M), top	1.274	79.62	47.50	9.00	56.50	40.60	3.50	43.80	7508.	White.
Warrick	Chandler's, (M), middle	1.282	80.12	49.50	5.50	55.00	41.50	3.50	45.00	7898.	White.
Warrick	Chandler's, (M), bottom	1.283	80.18	45.00	16.50	61.50	34.50	4.00	38.50	6801.	White.
Warrick	Millersburg, (N) middle	1.242	77.62	53.00	2.50	55.50	41.50	3.00	44.50	8090.	Blue.
Warrick	Millersburg, (N), bottom	1.243	77.68	49.00	2.00	51.00	45.50	3.50	49.00	8042.	Brown.
Posey	G. Heldferl's, St. Wendell's	1.327	82.93	51.00	5.50	56.50	39.50	4.00	43.50	7745.	Brown.
Montgomery	B. Clover, near Waveland	1.254	78.37	52.00	3.50	55.50	41.50	3.00	44.50	8010.	White.
Montgomery	H. S. Burford, near Waveland	1.202	75.12	49.00	5.00	54.00	43.50	2.50	46.00	7950.	White.
Parke	Moore's Mill, on Sugar Creek	1.228	76.75	46.50	3.50	50.00	46.00	4.00	50.00	7977.	Brown.
Vermillion	Charles Moore's mine	1.258	78.62	46.00	4.50	50.50	44.00	5.50	49.50	7751.	Flesh.
Sullivan	Dick's, 5 years old	1.239	77.43	55.00	1.50	56.50	40.00	3.50	43.50	8114.	White.
Sullivan	Dick's, fresh from mine	1.258	78.62	50.50	1.50	52.00	43.50	4.50	48.00	8071.	White.
Daviess	J. S. Morgan, top, No. 1	1.277	79.81	56.00	5.50	61.50	32.50	6.00	38.50	7507.	Red.
Daviess	J. S. Morgan, bottom, No. 2	1.252	78.25	53.50	5.00	58.50	36.00	5.50	41.50	7626.	White.
Daviess	J. S. Morgan, lower seam, No. 3	1.239	17.44	53.00	2.50	55.50	39.50	5.00	44.50	7906.	White.
	Connellsvilla, Pennsylvania	1.280	80.00	65.00	6.50	71.50	24.00	4.50	28.50	7454.	White.
	Stone's Gas coal, Pennsylvania	1.292	80.75	58.00	5.00	63.60	34.00	3.00	37.00	7805.	White.
	Mud River, Kentucky	1.280	80.00	57.00	2.50	59.50	37.00	3.50	40.50	8000.	White.
	Sardrle, Kentucky	1.325	82.81	51.00	4.50	55.50	42.50	2.00	44.50	8020.	White.

VIGO COUNTY.

This county lies on the western border and almost midway between the north and the south boundary lines of the State. It was named in honor of Col. Francis Vigo, who came from the republican land of Sardinia to St. Louis when it was a military post under the dominion of the Spanish Government. Here he early acquired the honored distinction of "Spanish merchant." Col. Vigo moved to Vincennes prior to its capture by Gen. George Rogers Clarke, and advanced sums of money to feed and clothe his suffering army. He also conveyed to that officer the information which enabled him to capture the post of Vincennes.

The money which was so generously advanced to relieve the destitute condition of General Clarke's army was not recovered from the state of Virginia, in full, until after Col. Vigo's death. He died very poor, but left a bequest in his will, in the event of his claims against Virginia being paid, that five hundred dollars should be given to the county which had honored him by the adoption of his name, to be expended in purchasing a bell for its court house.

Col. Francis Vigo had a high reputation for integrity, liberality and for his firm support of the American government. In addition to these brief notes, derived from the published sketches of Col. Vigo, it may be a matter of interest to scientists to state that he and Mr. John Badolet, the first Register of the Land Office at Vincennes, and a noted Indian interpreter, were intimate friends of the celebrated naturalist, C. A. Lesueur, who lived at New

Harmony, Posey county. I can well remember seeing the three together, and have in my possession a profile portrait of Col. Vigo and Mr. Badolet, exquisitely drawn by Lesueur and lithographed by Mrs. Mezzara.

This county was organized in 1818, out of a portion of the original territory of Sullivan county, and contains about 400 square miles. The topography is not marked by any prominent hills or rugged scenery. In the northwestern part, the table land has an elevation of from 130 to 190 feet. A low amphitheatre of hills skirt along the western border and give rise to a generally level table land. Prairies occupy a large portion of the central area of the county and the townships bordering on the Wabash river. The Wabash river runs in a southwest direction through the northwest part of the county, and at the southwest corner forms the boundary between Indiana and Illinois. Numerous small streams that rise in the table lands on the east and west find their way into the Wabash river in such a manner as to furnish an abundance of running water to every township. Splunge creek and other tributaries of Eel river rise in the extreme southeast corner of the county.

Terre Haute, the county seat of Vigo county, is on the east bank of Wabash river. It derives its name from the French *terre*, land, and *haute*, high, signifying high land. The location is on a level river terrace, 45 or 50 feet above low water. The location is all that could be desired for health and beautiful surroundings. The city is regularly laid off and contains a number of large and elegant public and private buildings. The Normal School building, and the Rose Polytechnic School are buildings that display much taste and elegance of design. The latter building, with a liberal endowment of four hundred thousand dollars, is the munificent gift of Mr. Chauncey Rose to the city, and no worthier monument can be devised to commemorate his many good acts, and the firm devotion of this noble man to the city of his adoption.

The Rose Polytechnic School is destined to become one

of the most important educational institutions in the West. The philanthrophy and generosity of Mr. Rose does not, however, stop with the building and endowment of this institution, for he has also furnished the means to erect an Orphan's Home and endowed it with a fund of $350,000. Terre Haute is the seat of many large branches of manufacture. There are already here two large blast furnaces, nail works that turn out 3,000 kegs weekly, a merchant rolling mill, railroad machine shops and a variety of other manufactories. Nine railroads connect Terre Haute with the surrounding country, and the Wabash river is navigated a great portion of the year by small steamboats, that ply between it and the towns, for some miles, up and down the stream. Indeed, no city in the West is more favorably situated as regards means of transportation, and cheap fuel for the economical production of all kinds of manufactures. The population has more than doubled in the last ten years and is now estimated at 28,000 to 30,000. There are flourishing villages in each of the twelve townships forming the civil divisions of the county.

GEOLOGY.

The entire surface of this county is covered by quaternary deposits, which rest immediately on the coal measures. The latter formation, where penetrated by artesian wells bored in the city of Terre Haute, is about 450 feet thick. The first coal reached is probably referable to I, and if we add the strata, which is found above this coal, at the Seelyville mines, 86 feet less the drift, it will give 536 feet as the thickness of the coal measures of this county. At the eastern edge of Terre Haute, where the first and second wells were bored, the drift and alluvial is 150 feet thick, and the well reached probably as low as the Niagara beds. These wells, therefore, furnish important information of the strata which underlie the coal measures; and since the coals which it passes do not crop in the county, the entire section is given.

SECTION OF TERRE HAUTE WELL,

As reported by the company who had the work in charge:

	Ft.	In.
Sand and gravel	100	00
Soapstone	64	06
COAL I.	6	02
Hard sandstone	2	03
Soapstone,	10	00
COAL G.	3	00
Soapstone	4	03
Gray sandstone	5	10
Blue soapstone	0	10
Gray sandstone	0	06
Blue soapstone	12	09
Soft black shale	6	00
COAL F.	0	09
Soapstone	7	07
White sandstone, (Conglomerate)	30	03
Blue shale	7	02
COAL B.	2	03
Black shale	10	00
White soapstone	3	00
Black shale	15	00
White soapstone	8	00
Black shale	3	03
COAL A	3	00
Soapstone	17	09
Sandrock	3	00
Soapstone	20	00
Sandrock	10	00
Blue shale	22	00
Limestone	2	00
Blue shale	31	00
Light shale	5	00
Blue shale	60	00
Sandstone	7	00
Blue shale	24	00
Sandstone	3	00
White shale	10	00
Blue shale	147	06
Hard, gritty, slate rock	11	07
Hard, gray, fine sandstone	14	05
Hard limestone	11	00
White limestone	24	00
Gray sandstone	2	00

	Ft.	In.
Limestone	14	00
White limestone	82	00
Soapstone	3	00
Brown limestone	35	00
Soapstone	5	00
Lime rock	9	00
Soapstone	6	00
White limestone	7	00
Soapstone	2	00
White limestone	21	00
Gray limestone	5	00
Lime and soapstone, mixed	5	00
Gray limestone	5	00
White limestone	15	00
Blue limestone	2	00
STRONG SULPHUR WATER.		
Gray limestone and flint	73	00
Light gray limestone	7	00
Blue gray limestone	7	00
Soapstone—fire clay	26	00
Gray limestone	24	00
Gray sandstone	3	00
Soapstone—fire clay	5	00
Shale and quartz, mixed	166	00
Slate, quartz and sandstone	3	00
Slate rock	21	00
Soapstone	33	00
Slate rock	7	00
Soapstone	235	00
STRONG SALT WATER.		
Soapstone and sandstone	10	00
Fine sandstone	15	00
Blue soapstone	40	00
Black shale	15	00
Red shale	5	00
Black shale	15	00
SATURATED WITH OIL.		
Lime rock	5	00
Black shale	5	00
Gray lime rock	149	00
Gray sand rock	23	00
Lime rock	73	04
SULPHUR WATER.	1912	05

It is of course very difficult to decide, with certainty, on

the correlation of strata of coal when no other means are furnished than the simple record of a bore kept by parties who possess but a limited knowledge of the specific character of rocks, even when exposed to view at the surface, much less when brought up by the sand pump in the condition of fine sediment.

At Seelyville, on the Terre Haute & Indianapolis Railroad, M. Hough, of Terre Haute, superintended the sinking of a coal shaft some years ago for the Indianapolis Rolling Mill Company, and furnished me an accurate section of what it passed through as far down as the bottom of coal L; from thence a bore was made to the additional depth of 125 feet. The following section is taken from Mr. Hough's record. In 1869 I went down this shaft and found the record reliable so far as I could follow it.

SECTION OF SEELYVILLE SHAFT,

On section 14, township 12, range 8. Mine now owned by Arbuckle & Budd:

	Ft.	In.
Drift	11	00
Quick sand	5	00
Hard pan	15	00
COAL N	2	09
Fire clay	7	06
Sandstone	1	06
Soapstone	12	09
Fossil ore	0	06
Soapstone	7	07
Slate	1	06
COAL M	0	06
Fire clay	5	08
White sandstone	4	00
Dark sandstone	5	00
White sandstone	14	06
Soapstone slate	0	10
COAL L	6	02
Fire clay	4	00
Sandstone	4	06
Black slate	1	06
Bastard limestone	2	06
Black slate	1	08

	Ft.	In.
COAL K	1	10
Fire clay	5	00
Soapstone	9	06
COAL J	0	06
Sandstone	4	00
Fire clay	7	00
COAL I	1	01
Slate	0	05
COAL	1	09
Fire clay	10	06
Black slate	2	00
COAL H	1	05
Fire clay	3	09
Soapstone	4	06
Fire clay	5	00
Soapstone	2	09
Sandstone	3	01
Soapstone	5	06
Black slate	0	07
COAL G	0	05
Soapstone	1	06
Sandstone	5	04
Soapstone	7	00
Sandstone	1	00
Soapstone	1	00
Sandstone	6	02
Slate	2	06
COAL F	1	02
Sandstone	7	06
Fire clay	1	03
Gray slate	5	00
	225	11

About a quarter of a mile south of Arbuckle & Budd's mine, on the same section, is the old Perrin shaft, 43 feet to the bottom of coal N, which is here 5 to 6 feet thick. The Seelyville shaft starts from a topographical horizon, one hundred feet by railroad levels, above the mouth of the bore, at Terre Haute, and by means of the two sources of study we are enabled to make a complete section of all the strata in the county. By following coal N, from Seelyville, west, it is seen to crop on Lost creek, on Alexander McPherson's place, section 16, township 12, range 8, at an elevation of 42 feet above Terre Haute, which gives a dip of 27 feet in

a horizontal distance of one and a half miles, or about 18 feet to the mile.

It is a singular fact, that all the coal seams along the streams, both in Clay and Vigo counties, nearly conform to the fall and rise of the beds of the creeks. Along the Middle and North Forks of Otter creek, in Clay county, and along the branches of Lost creek, and the main Otter creek, in Vigo county, this fact may be observed. The coal strata also, as a general rule, rise and fall with the topography of the country, and where there is a long stretch of level table land the seams of coal and accompanying strata will be found nearly horizontal. Therefore, it will not do to estimate a uniform dip of 18 feet to the mile, over the 5 miles level territory between McPherson's and Terre Haute. But even at this rate, it would only carry N 38 feet below the surface, and L (62 feet below) to a depth of 100 feet. But, even at this great depth, both N and L would have been removed by the glacial forces which swept down the valley of the Wabash, removed pre-existing strata and left the plain between the hills on the east and west filled with erratic boulders, hard pan, gravel, clay and sand to the depth of 150 feet, as proved by the artesian bores. The hills and table lands on the east side of the Wabash are the counterpart of the hills and table land on the west side of that stream. If my deductions from the above facts are correct, and after taking into consideration the variations in space usually found in different parts of the measures between respective seams of coal, then coal I is probably the first seam of coal penetrated by the bores at Terre Haute. The coals then that lie above seam I have been removed for at least the greater part of the distance between the Wabash river and McPherson's. Five and a half miles west of Terre Haute, along the east slope of the hills, coal L is reached by shafts at about 70 feet below the level of the railroad depot at Terre Haute, and the superior seams M and N appear as thin beds in the hills above.

Coal L is the lowest seam of coal worked in the county.

The colliery at Seelyville was recently sold by Mr. Seely to Arbuckle & Budd. It has a good arrangement for hoisting and delivering coal to the cars. The shaft is only six by twelve feet, and the new company design enlarging it, since it has proved to be inadequate to meet the growing demand for the coal. The seam is caking coal, 6½ feet thick, and has a three inch shale parting 3 feet below the top. The upper part contains numerous joints or vertical fractures that are filled with thin scales of transparent calc spar; these joints predispose it to break into cubical pieces. The color is brilliant black. The lower part of the seam contains fewer joints, is of a bright black color, and the coal is firm and hard. Though the coal, itself, contains but little sulphur, there is disseminated through the seam bands of iron pyrites (*mundic* of the miners). This mineral if mixed with the coal is highly injurious to the boilers, grate bars and fire boxes of locomotives, but being in bands it is easily separated.

ARBUCKLE & BUDD'S COAL:

	Top.	Bottom.
Fixed carbon	48.00	50.00
Gas	45.00	43.50
Water	3.50	3.00
Ash, white	3.50	3.50
Coke	51.50	53.50
Heat units	8007.	8031.
Specific gravity	1.211	1.250
Weight of 1 cubic foot	75.68	78.12

Coke: puffed, lustreless, amorphous.

The calculated heat units are 8031. One pound of coal will convert 12.31 pounds of water from 0°C. into steam at 150° C.

The practical evaporative power of a coal is found to be about one-third less than is indicated by calculation. Then in practice one pound of the Arbuckle & Budd coal should convert 8 pounds of water from 0° C. into steam at 150° C. These analyses show that this is an excellent coal. It will make a good coke and possesses a high evaporative value.

The immediate roof of L at this shaft is an argillaceous

shale as shown in the vertical section given above. Coal L crops on another branch of Lost creek about one mile south of Seelyville, on W. B. Dickinson's place and it might be reached by shafts over almost the entire eastern half of Lost Creek township, and over almost the whole of Nevens township in the northeast corner of the county.

On the Indianapolis & St. Louis railroad, sections 8 and 9, township 13, range 7, this seam is worked by two entries that penetrate the coal on opposite sides of the railroad and only a few hundred yards apart. The seam lies a little below the level of the railroad track, is 6 feet thick and has a shale parting similar to what is seen at Seelyville 3½ feet below the top. The south mine was first opened and worked by Daniel Webster, who sold it to a company that have conferred upon it the name of Litchfield Coal Company. The north mine is known as Webster & Brammel Coal Company. The appearance of the coal in each of these mines is strikingly similar to Arbuckle & Budd's coal, and the analyses also agree very closely.

WEBSTER & BRAMMEL'S COAL:

	Top.	Bottom.
Fixed carbon	48.00	47.50
Gas	46.00	45.50
Water	3.00	3.00
Ash ... purple,	3.00	red, 4.00
Coke	51.00	51.50
Heat units	8098.	8013.
Specific gravity	1.197	1.210
Weight of 1 one cubic foot	74.81	75.62

Coke: puffed, lustreless, amorphous.

The calculated heat units of the top part of this coal being 8098., one pound will convert 12.42 pounds of water from 0° C. into steam at 150° C. Practical evaporative power; one pound will evaporate 8.28 pounds of water from 0° C. into steam at 150° C.

For the bottom part of the coal the calculated heat units are 8013., therefore, one pound will convert 12.3 pounds of water from 0° C. into steam at 150° C. In practice one pound will convert 8.2 pounds of water from 0° C. into steam at 150° C.

The place where these mines are located is called Webster Station; it is only half a mile west of the Clay county line at Lodi, and is situated on the main bottom formed along the north branch of Otter creek. At the old entry to coal L at Webster, the seam is about on a level with the railroad track, and the coal is raised on an inclined tresselwork tramway to the tip house which is built over the railroad at an elevation which admits of the coal being slid down into the cars; it being one of the principal coaling stations on the Indianapolis & St. Louis railroad.

Coals M and N, though not seen above L immediately at Webster, make their appearance farther up the stream on the side of the hill at Lodi, and their places are indicated in the following section:

SECTION BETWEEN LODI AND WEBSTER:

	Ft.	In.
Drift, clay and soil	48	00
Hard bituminous shale, (N ?)	2	00
Good coal	0	08
Gray argillaceous shale	8	00
Black shale	1	00
Good coal in blocks (M)	1	06
Siliceous shale	10	00
Micaceous shale	4	00
Argillaceous gray shale	1	00
COAL L	6	06
Bed of Otter creek.	82	08

The two seams above L lie very irregular and are in curved basins. In a space of 25 yards they are seen to dip 3 feet, and on following down Otter creek from Lodi, they make their appearance at various points along the stream and are last seen near Grant's Station, 5 miles south-west, at about the same level above the creek. The rate of dip in that direction, by railroad levels, is only 8 feet to the mile. At Grant's Station I was informed that a well was bored which penetrated a thick coal 30 to 40 feet below coal M.

Daniel Webster lives about a mile northeast of Webster

station, on southwest quarter, section 5, township 13, range 7, and 60 feet by barometric measurement above Otter creek at Lodi. In 1871 he had a well drilled on the west side of his farm nearly north of the mines at Webster. It commenced on level table land and passed through the following strata, as reported by Wilson Crossly, who had the work in charge:

BORE ON DANIEL WEBSTER'S FARM.

	Ft.	In.
Surface soil and clay	3	00
Sand	1	00
Plastic potter's clay	5	00
Sand	8	00
Hard pan	10	00
Sand	1	06
Hard pan	8	06
Sand	1	00
Hard pan	8	00
Plastic potter's clay	7	00
Sandy shale	13	08
COAL L	7	00
	73	08

The last 7 feet probably includes some of the shale roof. The depth at which the coal is found corresponds very closely to the level of the seam at Webster's Station. Coals M and N have been removed by glaciation. East of this well, and on the same farm, Mr. Webster had another well drilled in the following October, by V. Young. This well passed through:

	Ft.	In.
Surface soil and clay	15	06
Sand	8	00
Potter's clay	9	06
Gray shale	4	00
Black shale	13	00
Coal and shale (N ?)	3	00
Shale	5	00
Coal and black shale (M)	4	06
	62	06

This well passed through the two coals that crop on the

bank of North Otter creek at Lodi, and if it had been carried to about the same depth as the first, would have penetrated Coal L.

At Fountain Station, one and a half miles southwest of Webster, Coal M is seen at the water's edge, but N has been removed by glaciation. About a quarter of a mile southwest of Fountain, G. W. Mooreland has sunk a shaft to Coal L. This shaft commences on the south bank of North Otter creek.

SECTION ON MORELAND'S FARM:

	Ft.	In.
Sand and clay	22	00
Coal M	1	04
Fire clay	3	00
Sandstone and sandy shale	4	00
Gray shale	8	00
Coal L	5	10
	44	02

In general appearance this resembles the Webster and Seelyville coals. There is a shale parting at the same distance from the top, and it contains vertical joints filled with calc spar.

MOORELAND'S COAL:

Fixed carbon	47.50
Gas	43.50
Water	4.50
Ash, reddish brown	4.50
Ccke	52.00
Heat units	7829.
Specific gravity	1.195
Weight of 1 cubic foot	74.70

Josiah Lambert, who lives on a farm, which joins Fountain on the north, had two wells drilled on his place for coal. The first is situated near the centre of section 13, township 13, range 8, and only a few rods from the railroad track, and the second well in the northeast corner.

SECTION ON JOSIAH LAMBERT'S FARM:

First Bore.

	Ft.	In.
Yellow sand	5	00
Hard pan	8	00
Quicksand	24	00
Shale	1	00
COAL M	1	06
Fire clay	3	00
Black shale	3	00
Gray shale	7	00
Soapstone, (Argo. shale.)	3	00
COAL L	7	00
	62	06

The second well was situated on the table land about 30 feet above the level of the first.

Section of Second Bore.

	Ft.	In.
Yellow clay	4	00
Hard pan	24	00
Sandstone	12	00
Soapstone	10	00
Limestone	2	00
Soapstone	12	00
Limestone	5	00
Soapstone	5	00
Black slate	3	00
Coal	7	00
	84	00

The record of the first bore corresponds so close to what is seen in the shaft, that no room is left to doubt its accuracy. The account of the second bore, however, differs from either in all but the coal at the bottom, so that one is left to question its accuracy in every particular. The limestones were not seen here in my surface examinations, though I followed up a ravine, which cuts the table land near by, expressly to look for them. There is, nevertheless, a thin limestone, sometimes over coal N, and if we are to be guided by this fact, the coal reported as 7 feet thick, has its thickness over-estimated, and the 3 feet of black shale

and 7 feet of coal may be parts of coal N and M, which are sometimes separated by only a few inches of shale.

Near Grant's Station, at the old Titcomb mine, (Coal N), coal M is on a level with the railroad track and, by railroad levels, 56 feet above low water in the Wabash river at Terre Haute. The place of coal L, as shown by the sections at Webster and Fountain, lies not more than 20 feet below M. Now, if we assume that the rate of dip continues from Grant's Station to Terre Haute, 3 miles southwest, at the same rate, 8 feet to the mile, as shown from Lodi to Grant, then the place of coal L at Terre Haute is near the level of the river, and has been removed by denudation, but makes its appearance, at about the level of low water at the foot of the hills on the west side of the stream about 2½ miles from Terre Haute. The most southerly point where it is worked on the west side of the river is at the crossing of Sugar creek on section 30, township 12, range 9, at Barrick & Sons' mine. Here, the shaft, which is sunk on the side of the creek, is 30 feet deep and the coal is 4 feet 6 inches to 5 feet thick. It lies on a level with the bed of the creek and some trouble has been experienced by the water of the stream finding its way into the mine. Going north from Barrick & Sons' mine I followed coal L by numerous shafts and crops to the extreme northern part of the county. The following is a section of the hill and shaft:

BARRICK & SON'S.

	Ft.	In.
Drift, clay and soil	20	00
Schistose sandstone	10	00
Limestone containing *Productus punctatus*	1	00
Siliceous shale and argillaceous shale with ironstone.	30	00
Gray, light colored argo. shale	12	00
Black shale	1	06
Coal L	4	06
Fire clay	10	00
	89	00

At Mackelroy's shaft, three-quarters of a mile north of Barrick & Son's, this seam is reached at 27 feet from the surface. At Edgerton's, three-quarters of a mile north of

Mackelroy's, the shaft is 40 feet to the coal, and at McQuilkin's, on section 7, township 12, range 9, the shaft commenced above the Indianapolis & St. Louis railroad, and is 80 feet to the coal. The coal in this shaft must be considerably above the level of the bed of Wabash river, and is overlaid by a thick bed of gray argillaceous shale that contains numerous thin bands of nodular ironstones. These ironstones are so numerous in the beds of the small streams, where they have tumbled from the washed banks above, that they are gathered up and sold to the Vigo Iron Company, to be smelted into iron. This shale is seen everywhere above coal L, on the west side of the river, and in connection with a bed of limestone, which lies from ten to twenty feet below the coal, furnishes a ready means for its identity. Some years ago a shaft was sunk to coal L, on the Vandalia railroad, about 3 miles west of Wabash river, on section 24, township 12, range 10, by Bigelow & Co. It was commenced on the side of the hill, immediately beneath the sandstone, and 8 feet above the railroad track.

SECTION AT BIGELOW & CO.'S

	Ft.
Covered to top of hill	50
Sandstone	10
Gray argillaceous shale with ironstone and fossil shells	46
Black shale	2
Coal	6
	114

The gray shale in this shaft, as well as at the shaft on Sugar creek, contains an abundance of coal measure shells: *Aviculopecten rectilateraria, Bellerophon carbonarious, Euomphalus rugosus, etc.*

The railroad grade is 57 feet above low water of Wabash river, and the shaft being 54 feet deep, makes the horizon of the coal about 11 feet above the bed of the river. A shaft was also sunk to this seam of coal at St. Mary's depot on the Indianapolis & St. Louis railroad. This shaft was 110 feet deep. It took fire in 1869 and was so completely

destroyed that no one has thought of restoring it to working order. I found the hill near St. Mary's by the aneroid to be 90 feet above the bridge at Terre Haute. The place where the shaft was sunk is probably a little higher, so that we may conclude that the horizon of the coal is here about the same elevation above the bed of the river as at McQuilkin's shaft. A boring was made for coal some years ago at Sanford, on the Indianapolis & St. Louis railroad and just on the border of Illinois. In 1858 Mr. Sanford furnished me with the following record of the strata which it passed through. I have not been able to find the railroad level for this locality but believe it is fully 200 feet above Wabash river:

SECTION AT SANFORD.

	Ft.	In.
Surface	15	00
Sand	6	00
Sand and clay	4	00
Hard pan	66	00
Brown clay	10	03
Blue clay	8	04
Sand	0	04
Blue clay	37	06
Black shale	1	03
Fire clay	4	05
Limestone	6	05
Red clay	2	00
Limestone	3	00
Soapstone	2	08
Limestone	0	09
Red slate	7	06
Hard pan	2	09
Limestone	3	00
Sand and clay	4	00
Limestone	1	09
Red slate	1	06
Sand and blue clay	5	03
Sandstone	3	10
Black slate	8	03
Black hard stone	0	09
Black slate	4	02
Bastard limestone	0	08
Slate	7	05

	Ft.	In.
Soapstone	5	03
Rotten coal	4	07
Sandstone	0	06
Fire clay	7	02
Sandstone	4	00
	240	03

It would appear from this record that no workable coal was encountered in the 240 feet penetrated by the Sanford bore. In all probability, since the drift is 148 feet thick, coal L has been removed by glacial action. About 10 miles north of Sanford, on the Indianapolis, Decatur and Springfield railroad, in Vermillion county, Indiana, coal L is reached by a shaft at the depth of 100 feet. The drift being only 94 feet as shown in the following section furnished by Charles Moore:

SECTION AT MOORE'S BORE.

	Ft.	In.
Surface, soil and clay	6	00
Sand and gravel	16	00
Hard pan	48	00
Sand	6	00
Hard pan	18	00
Soapstone	3	06
Hard rock (limestone)	0	04
Black slate	2	02
Coal	4	06
Fire clay	10	00
Soapstone	42	06
Coal and slate	2	06
Fire clay	1	06
Hard soapstone shale	9	06
Hard sandstone rock	7	06
	178	00

The following are the principal localities where coal L crops or is mined in Fayette and Sugar Creek townships:

Barrick & Sons', on Sugar creek, in northeast corner section 25, township 12, range 10.

Biglow shafts, near the center of sections 23 and 24, township 12, range 10

St. Mary's shaft, southeast corner section 1, township 12, range 10.

McElroy's shaft, section 19, township 12, range 9.

John Edgerton's shaft, section 18, township 12, range 9.

William McQuilkin's two shafts, sections 7 and 8, township 12, range 9.

J. S. Schae's shaft, section 8, township 12, range 9.

A. Conner's shaft, section 8, township 12, range 9.

A. Warner's north half, section 32, township 13, range 9.

P. W. Halleran, south part, section 29, township 13, range 9, three crops.

S. W. Case, on Coal creek, section 19, township 13, range 9.

B. Fingua, on Coal creek, section 19, township 13, range 9.

J. Hunter, on Coal creek, section 23, township 13, range 10.

J. Hennesy, on Coal creek, section 23, township 13, range 10.

J. Bolton, on branch of Coal creek, section 19, township 13, range 9.

F. Miller, on branch of Coal creek, section 19, township 13, range 9.

P. & G. Groves, on Salt creek, section 19, township 13, range 9, one mile north east of Durkey's Ferry.

D. Barbour, on Salt creek, section 8, township 13, range 9.

E. S. Rhyan, section 6, township 13, range 9.

F. Shepherd, section 5, township 13, range 9.

Indeed, coal L is seen at so many localities on the west side of Wabash river, that it may be found by shafts or bores in almost every township and section in the county north of Sugar creek. But there are reasons to believe that it will not be found in the southern part of Sugar Creek township. Coal L is readily recognized by the gray, argillaceous shale with iron-stone bands which everywhere overlie it, and the impure fossiliferous limestone which lies below it. This limestone occupies the position of the limestone which overlies coal K.

The following section made on Coal creek, section 19, township 13, range 9, will indicate the character of the strata which accompany this coal in Sugar Creek and Fayette townships, taken from the top of the hills to the bed of Coal creek:

SECTION ON COAL CREEK.

Buff, marly clay, loess, but no fossils..........		8 ft. 00 in.
Drift, sand and gravel		12 to 20 ft. 00 in.
Hard pan...		5 to 10 ft. 00 in.
Gravel, sand and boulders.........................		60 to 70 ft. 00 in.
Limestone		1 ft. 00 in.
Buff schistose sandstone, sometimes containing good bands of building stone.........		10? ft. 00 in.
Bluish gray argillaceous shale with bands of ironstone in flattened spheroidal masses containing fucoids and small shells.......		10 to 20 ft. 00 in.
Black shale, with thin partings of coal and impressions of flattened trunks and stems of sigillaria, etc..........................		1 ft. 06 in.
Coal L.....................................	3 ft. 08 in.	4 ft. 08 in.
Shale parting	0 ft. 0¾ in.	
Coal L.....................................	1 ft. 00 in.	
Fire clay and shale................................10 to 15 ft. 00 in.		
Limestone with *Productus cora*, *P. punctatus*, *etc.*		1 ft. 6 in.
Bluish gray, micaceous sandstone, excellent building stone, in places often schistose and sometimes sandy shale with a waved surface		30 ft. 00 in.
Coal Creek.		192 ft. 8 in.

The upper part of the seam of coal is jet black, glossy, contains numerous vertical joints filled with calcite and in every respect resembles the coal at Seelyville, Webster and Fountain. Bands of pyrites are also disseminated through the seam and require attention to keep it out of the coal designed for market.

In the gray argillaceous shale which overlies coal L, two remarkable fucoids are found in great abundance, preserved in ironstone nodules. These fossil sea plants were sent to Prof. L. Lesquereux for identification. He found both species new to science and has furnished me with drawings and descriptions which will appear further along. I first saw the large fucoid at Richmond, Indiana, in the cabinets of John F. Miller and Mrs. Mary P. Haines. I believed it to be new and Mr. Miller very kindly made me a present of one of the best he had. They were purchased of a

collector who gave the locality as Bruillet creek, Vigo county, Ind. The best locality that I found for these interesting fucoids is at Mr. Rhyan's mine, on section 6, township 13, range 9, about one mile from Bruillet creek. Here they have been washed out of the shale and lie in the bed and along the shores of a branch of Salt creek.

Though I was prevented from visiting the fossil plant bed at Durkey's ferry, I am satisfied that the shales which contain them, preserved in ironstone nodules, is the equivalent of the fucoid shales, for I find these shales and coal L on Salt creek and Coal creek, within one and a half miles of the ferry, as well as in the banks of Bruillet creek.

The following section showing the relation of the fossiliferous shales to coal L, at Durkey's ferry, has been furnished by Prof. John Collett:

SECTION AT DURKEY'S FERRY.

Light colored, (clay shale), with many ironstone nodules and flattened concretionary masses containing *Pecopteris arborescens*, *P. callosa*, *P. sp.?* *Neuropteris hirsuta*, *N. rarinervis*, *N. collinsii*, *Hymenophyllites sp.?*, *Alethopteris niagarensis*, *A. grandiflora*, *A. sp.?*, *Lepidodendron elegans* with leaves and cones of Lepidodendra, *Ulodendron punctatum*, *Sigillaria* imperfect specimen, *Calamites cannæformis* with leaves, *Cordaites borassifolia*, *C. angustifolia*, *Paleoxylis prendelli*, *P. corrugata*, *Annularia sphenophylloides*, *Sphenophyllum schlotheimii*, *Trigonocarpum olivæformis*, *T. triloculare*, *T. ornatum*, and many stems of ferns, and locally in nests, the nodules are covered with minute shells of *Leiaia tricarinata*		18 ft.	00 in.
Uncteous soapstone with leaves	1 ft. to	1 ft.	8 in.
Black shaly slate	0 ft. to	1 ft.	10 in.
COAL L, in bed of river		5 ft.	00 in.
		100 ft.	3 in.

Coal L, on the west side of the river, has about the same chemical composition that it has on the east side, as shown by the examples here given.

BARRICK & SON'S COAL L.

Seam, 4 feet 8 inches thick.

Fixed carbon	48.20
Gas	44.50
Water	3 00
Ash, reddish	4.30
Coke	52.50
Heat units	8000.
Specific gravity	1.192
Weight of 1 cubic foot	74.50

McQUILKIN'S COAL L.

Seam 4 feet 8 inches thick.

Fixed carbon	47.50
Gas	44.50
Water	4.50
Ash, white	3.50
Coke	51.00
Heat units	7921.
Specific gravity	1.210
Weight of 1 cubic foot	75.62

P. H. HOLLOMAN'S COAL L.

Seam 4 feet 8 inches thick.

Fixed carbon	42.00
Gas	42.00
Water	3.50
Ash, white	12.50
Coke	54.50
Heat units	7247.
Specific gravity	1.242
Weight of 1 cubic foot	77.62

F. RHYAN'S COAL L.

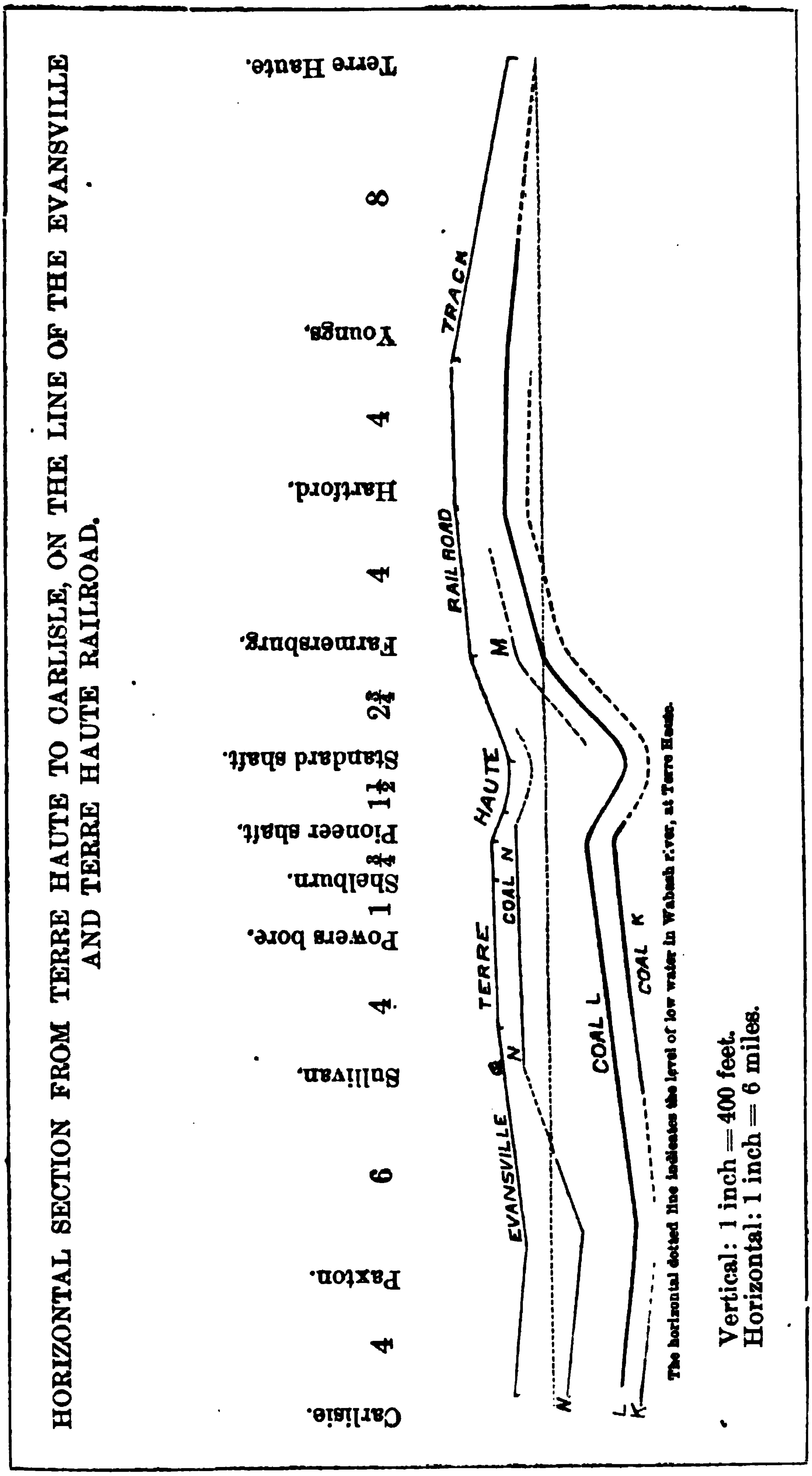
Seam 4 feet 8 inches thick.

Fixed carbon	48.50
Gas	43.50
Water	2.00
Ash, flesh	6.00
Coke	54.50
Heat units	7910.
Specific gravity	1.226
Weight of one cubic foot	76.62

In the south part of Vigo county, along the Evansville & Terre Haute railroad, coal L is reached by bores and shafts. At Young's Station, 8 miles from Terre Haute, the elevation is 112 feet above the depot, or 159 feet above low water of Wabash river at the latter city; and coal L is reached at the depth of 100 feet. At Hartford, 4 miles beyond Young's, the elevation is 4 feet less and the depth to the coal is 90 feet. Farmersburg, 16 miles from Terre Haute and just south of the Vigo county line, has an elevation of 135 feet above Wabash river, and coal L is 130 feet below the surface.

The horizontal section, on next page, made along the line of the Evansville & Terre Haute railroad, from depot at Terre Haute, running south for 36 miles to Sullivan, in Sullivan county, will serve to show the topography and relative position of coal L with reference to a horizon line starting from low water of Wabash river at Terre Haute.

At Young's, it will be seen that coal L is 59 feet, and at Hartford 68 feet above low water, and since it is found at about the level of low water, on the west side of the river at the latter place, the rise of the strata, going south, will average a little over four feet to the mile. From Hartford to Farmersburg the dip is south at the rate of 3 feet per mile. From thence to the Standard shaft the rate of dip is a little more than 52 feet to the mile. In the next mile and a half to the Pioneer shaft, it rises 40 feet; from there to Shelburn, half a mile, the rise is 28 feet, or 56 feet to the mile, corresponding closely to the angle of dip on the opposite side of the trough, at the Standard shaft. From Sullivan to Carlisle there is a pretty regular dip of 4 feet to the mile. It will also be observed in this section that the rise and fall of the coal seams correspond to the surface topography. At Hartford coal M was probably removed by the drift, as it loes not appear in the shaft.



HORIZONTAL SECTION FROM TERRE HAUTE TO CARLISLE, ON THE LINE OF THE EVANSVILLE AND TERRE HAUTE RAILROAD.

SECTION OF SHAFT AT HARTFORD.

	Ft.	In.
Soil and drift	37	00
Solid gray sandstone	40	00
Gray argillaceous shale with fossil plants	10	00
COAL L.	3	06
	90	06

The roof shales contain an abundance of well preserved filices and trunks of Sigillaria, Lepidodendron and Calamites. It is a grand sight to go down into this well arranged mine and see the ceiling in the entries, from which the coal has been removed, covered with its diversified fossil flora. Immense trunks of Sigillaria extend across this roof and are flanked by branching ferns that cover all the intervening spaces between the trunks of Sigillaria and Calamites with a rich foliage of glossy, black leaves on a matrix of bluish gray argillaceous shale. Indeed, the fossil flora of this mine excels in variety and perfect preservation of the plants any place that I have ever visited. A trunk of Sigillaria was measured, with the assistance of underground manager Duncan McCullum, and found to be eight and a half feet in diameter.

Mr. McCullum presented me with a number of fine specimens of these fossil plants which he had collected. Among them I recognized *Hymenophyllites alatus*, *H. pinnatifidus*, *Annularia longifolia*, *Neuropteris rarinervis*, *N. hirsuta*, *N. loschii*, *Sphenophyllum schlotheimii*, *Pecopteris arborescens*, *Cyclopteris elegans*, *Asterophyllites ovatus*, *Sigillaria obovata*, *S. occulta*, *S. menardi?* *Calamites cuneiformis*, *C. sp.?* *Lepidodendron sp.?*

While in the south part of the county this seam of coal is only 3 feet 6 inches to 4 feet thick, it nevertheless presents the same general characteristics noted at Seeleyville, Webster and the mines on the west side of Wabash river. It is a double seam and the upper part is glossy black coal with joints containing calc spar.

The mine at Hartford is now owned by J. S. Wyeth.

The tip-house and machinery are in first rate order. The engine being one of the best in the country for the purpose, and the entire mine is in good order for the delivery of coal into cars. Mr. Wyeth has been experimenting with his coal-slack to test its coking properties. To judge from the samples of the coke which he has made, there is but little doubt of his succeeding to make from this, at present wasted coal debris, a coke that will meet with a ready sale. The analyses of the upper and lower parts are here given:

J. S. WYETH'S COAL.

	Top.	Bottom.
Fixed carbon	49.00	51.00
Gas	41.00	42.00
Water	2.50	2.50
Ash, white	7,50	4.50
Coke	56.50	55.50
Heat units	7721.	7974.
Specfic gravity	1.237	1.216
Weight of 1 cubic foot	77.31	76.00

COAL M

Is the next seam following L, in the ascending order. It is found in Arbuckle & Budd's shaft, at Seelyville, but is there too thin to be mined. The shaft on the Perrin property, a half mile south of Seelyville, did not go deep enough to reach it. On the west side of Wabash river it appears as a thin seam in the hills along the Vandalia railroad, and on Clear creek, in section 34, township 12, range 10. It is found of workable thickness on Otter creek and its branches. Here it is sometimes seen only separated from N by a few inches of shale, and in such places the two may be worked together, as at Stewart's, one and a half miles south of Fountain, on section 24, township 13, range 8; also on section 30, township 13, range 8.

SECTION AT LODI,

In the western edge of Clay county:

	Ft.	In.
Surface and drift	30	00
Black shale	1	00
Coal N	1	06
Gray shale	8	00
Under Clay		
Black shale	2	00
Coal M	2	06
Fire clay		
Siliceous shale	10	00
Bed of Otter creek.	55	00

The black shale forming the roof of M and N is highly bituminous and so closely resembles cannel coal that it may be easily mistaken for that valuable fuel. Some years ago, D. Titcomb sent some samples of the bituminous shale overlying coal N, at Grant station, to this office for examination, and it was found to contain in 100 parts:

Water	4
Volatile gas	25
Fixed carbon	39
Ash, fawn color	32

This shale will burn and make a very hot fire but it will not consume to a pulverulent ash; the incombustible residue is a more or less compact stone. It also contains hydrocarbon oils and gas but not in quantity sufficient to be extracted with profit. This is mainly because the residual coke will prove valueless.

Coal M has imbedded locally in the overlying shales large limestone concretions that contain numerous fossil shells of which I recognized *Productus punctatus* and *P. spinosus*. The associated black shale contains *Aviculopecten rectilateraria*, gilt with iron pyrites, and scales and fins of fish. *Petrodus occidentalis* and similar fish remains are also found in the shales over coal N.

At Grant's station coal M is seen along the southern shore of Otter creek for several hundred yards, and the crop is just above the bed of the stream. Mr. Henry

Brayton is mining it along the bank by stripping off the superincumbent shale It is considered a very good coal for domestic purposes. The following is the analysis of

HENRY BRAYTON'S COAL.

Fixed carbon	44.00
Gas	44.00
Water	3.50
Ash, red	8.50
Coke	52.50
Heat units	7592.
Specific gravity	1.216
Weight of one cubic foot	76.00

Coke: puffed, amorphous, lustreless. One pound will convert 11.6 pounds of water from 0° C. into steam at 150° C.

A bore was made to test the existence of lower seams on the north side of the creek, close to and a little below the railroad grade at Grant's Station. It commenced below M and was carried to the depth of 110 feet. Artesian water is flowing out the top of this well which has a strong chalybeate taste. The following section shows the strata in the bank above coal M and what was passed through by the bore:

SECTION OF BORE AT GRANT'S STATION.

		Ft.	In.
Drift		8	00
Hard, black bituminous cannel-like shale	6 to	8	00
Coal N	22 in.		
Shale parting	2 in.	3	10
Coal	10 in.		
Under clay and argillaceous shale with large limestone concretions		6	03
Black pyritiferous substance, with soft carbonaceous matter, resembling charcoal		0	04
Coal M		1	01
Under clay		1	00
The bore commenced above the base of this coal and passed through:			
Sand and clay		73	00
Argillaceous shale		19	02
(Place of artesian water).			
Sandstone		3	00

	Ft.	In.
Black shale	2	00
Coal I?	2	06
Under clay	1	10
Argillaceous shale	12	00

Everywhere seen along the north branch of Otter creek, coals M and N hold the same relation to each other as exhibited in the above section. N is divided in two parts by a thin parting of shale or clay, is overlaid by hard black bituminous shale, and is separated from M by 6 to 10 feet of gray friable clay, resembling the usual under-clay of coal seams. It has also a roof of hard black bituminous shale with large concretionery balls of impure limestone.

Where this well is bored, in the narrow bottom on the north side of the creek, coal L has been removed by the changing currents of the creek or other abrading forces. On the south branch of Otter creek, in section 30, township 13, range 7, these two seams come close together, and including the two clay partings, have a total thickness of 6 feet to 6 feet 6 inches. After leaving Grant's station and going west to Wabash river, a distance of 6 miles, the country is nearly level and coals N, M and L have been removed by the agency of the glacial drift, and the crop of stratified rocks are not met with until the hills already alluded to are reached on the west side of Wabash river, except at Durkey's ferry.

In Riley township, at Somerset, on the Terre Haute & Cincinnati railroad, and half a mile west of Lockport, the Somerset Coal Company sunk a shaft in 1873, to coal M. This shaft commenced 10 feet above the railroad grade, which is here 35 feet above Terre Haute, and the top of the shaft 114 feet above the bed of Wabash river. The coal is 44 feet below the top of the shaft, or 70 feet above the bed of Wabash river at Terre Haute.

The following section of the strata passed through at Somerset, was obtained from W. J. Jones, a partner of the Company, who assisted in the work of sinking the shaft.

SECTION AT SOMERSET.

			Ft.	In.
Soil and clay			17	00
Coal rotten	2 ft. 00 in.	N	3	07
Fire clay	2 ft. 00 in.			
Coal, good	1 ft. 07 in.			
Fire clay			1	00
White sandstone			6	00
Black, bituminous shale			1	07
Impure limestone			6	00
Black, bituminous shale			9	00
Coal			5	04
Fire clay, hard			2	00
			51	06

Four inches next to the roof is inferior pyritiferous coal, and the lower part of the seam is the best. It has no partings.

Analysis of the lower part of this coal gives in 100 parts:

Fixed carbon	51.00
Gas	43.00
Water	4.50
Ash, white	1.50
Coke	52.50
Heat units	8066.
Specific gravity	1.210
Weight of 1 cubic foot	75.62

Coke: puffed.

This indicates a very good coal. One pound will convert 12.37 pounds of water from 0° C. into steam at 150° C.

The company has a good engine and dump house, and is preparing to mine all the coal that can be sold.

About one mile northeast of Somerset mine, J. S. Foote, of Terre Haute, had a bore made for coal, on section 9, township 11, range 8. He furnished me with samples of the seams penetrated, and their depth and relative positions. The bore commenced on the bottom of Honey creek, and close to the hills.

FOOTE'S BORE ON HONEY CREEK.

	Ft.	In.
Surface clay	8	00
Black shale	3	00
COAL N	?	
Shale	57	00
Limestone	2?	00
Black shale	3?	00
COAL M	3	06
Space	39	00
COAL L	?	

The man engaged to bore this well was inexperienced, and Mr. Foote was not sure that the thickness of the coals were accurately ascertained. The spaces are about right for this part of the county where N, M and L are quite close together, but going west the spaces augment rapidly and the upper seams, when present, are not of workable thickness, especially where seen along the Evansville & Terre Haute railroad, as shown by the sections already given.

A sample of the boring sent to me from seam M in Foote's bore, gave:

FOOTE'S BORE.

Fixed carbon	50.10
Gas	44.40
Water	3.70
Ash, light brown	1.80
Coke	51.90
Heat units	8123.
Specific gravity	1.217
Weight of 1 cubic foot	76.06

Coke: puffed, dull, amorphous.

One pound of this coal will convert 12.45 pounds of water from 0° C. into steam at 150° C. This gives promise that the seam will prove a valuable one.

Coal M may be found over a large area in Riley township.

Though variable in thickness it is of fair quality for domestic purposes, and at most places will be found sufficiently thick to justify mining.

COAL N.

This is one of the most unreliable seams in the county, both as regards persistence and thickness of the coal. It is of good workable thickness on the old Perrin property adjoining Seelyville. Here it is reached at the depth of 40 feet and was mined to some extent in 1869, but the shaft, then in good order, is now filled up and the mine abandoned. About one and a half miles a little south of west from Seelyville and near the Vandalia railroad, N has been opened on J. McPherson's land, section 16, township 12, range 8. The coal is mined by running an adit into the ridge which skirts along the south shore of Lost creek. It is 15 feet below the railroad level and the dip west from Seelyville to this place is at the rate of 18 feet to the mile.

SECTION AT M'PHERSON'S—SEELYVILLE.

		Ft.	In.
Soil and drift		20	00
Sandstone		30	00
Black shale		0	00
Caking coal	2 ft. 00 in.		
Shale	0 ft. 00½ in.	5	04½
Semi-block coal	3 ft. 04 in.		
Under clay		0	00
		55	04½

ANALYSIS OF M'PHERSON'S COAL.

Fixed carbon	56.50
Gas	37.00
Water	2.50
Ash, white	4.00
Coke	60.50
Heat units	7959.
Specific gravity	1.239
Weight of 1 cubic foot	77.43

Coke: slightly puffed, amorphous, brilliant.

Coal N, the highest coal in the series, is not found of workable thickness in this county at any point west of McPhersons and Grant's station, on the Indianapolis & St. Louis railroad. It is found in the hills on the west side of

Wabash river, and at numerous places in the south part of the county, but at these localities seldom attains to more than eighteen inches in thickness; still, at the crop it may be worked in favored positions, to supply neighborhood demands, by stripping off the superincumbent shales and earth.

QUATERNARY.

This epoch includes the beds of alluvial, loess, marl, clay, gravel, sand, boulders, etc., which lie immediately over the palæozoic rocks in Indiana. In Vigo county, these deposits have been proved by the Terre Haute deep wells, to be at least 150 feet thick. The boulders which lie near the bottom of the glacial drift, are mostly crystalline rocks, that were torn loose from the parent beds, that are in situ, far to the north of the State, and transported thither by the powerful glaciers which covered the country in the arctic and temperate regions, following the close of the coal era. The gravel is a mixture of crystalline and sedimentary rocks. At the hills east of Terre Haute, on land adjoining the farms of Joseph Gilbert and A. B. Pegg, where a branch of Lost creek cuts its way through the ridge, there is a fine exposure of glacial drift. The face of the exposure is almost vertical, and the deposit is 60 feet from the bed of the branch to the top of the bluff. Springs break out from the horizon of the boulder clay in almost all localities where it is exposed. Mr. Pegg and others have taken advantage of the springs that flow from this horizon, to construct fish ponds in favorable localities, by building dams across the valleys. Some years ago a bore was commenced at the foot of the hills on Church run, for coal, but was only carried to the depth of 20 feet. Here artesian water was reached, which flows out at the top. It has a slight chalybeate taste, but otherwise appears to be free from mineral matter.

Loess forms a capping to the drift on the high ridges and is from 20 to 25 feet thick. I was unable to find in it fossil shells of any kind.

BUILDING STONE.

The sandstone above and below coal L is sometimes found of good thickness and sufficiently firm and durable to be used for making foundations to inexpensive buildings. I know of but one locality in the county where a good durable stone may be obtained. This is seen below the limestone which underlies coal L in the bluffs bordering Coal creek, Fayette township. It is a bluish-gray, fine grained sandstone, that was at one time quarried by Mr. McQuilkins. The layers are generally thin, seldom reaching a foot. It rings under the hammer and will present a handsome appearance in a building.

There are two or more horizons at which an impure limestone may be had in this county; one lies above coal N, and the other is below coal L. This rock is totally unfit for building purposes and makes an inferior quick-lime; where exposed to the weather it is decomposed and shows unmistakable signs of decay. Going west, into Clark county, Illinois, the limestone over N becomes very thick, 20 to 35 feet; is of a light blue color, and but for its unmistakable coal measure fossils, might be taken for the cavernous beds of the sub-carboniferous limestone.

BRICK AND POTTERS' CLAY.

The clay which immediately underlies the coal seams is, in most parts of the county, suitable for making coarse jugs, milk crocks, roof-tile, drain-tile, etc.

Clay suitable for brick may be had on almost every farm in the county, being especially good on the ridges or uplands.

PETROLEUM.

Three wells that reached petroleum bearing strata have been bored at Terre Haute. The principal supply of oil was probably found in the upper part of the Niagara beds. The second well bored, furnished from two to four barrels of moderately heavy oil in twenty-four hours. It did not flow out at the top, but had to be

pumped. This materially enhanced its cost and owing to the extreme low price petroleum has commanded in the market for some years, the well was abandoned and closed up. The third well bored on the bank of Wabash river, in the edge of the city, found but little oil but discharges a vast column of sulphuretted hydrogen water similar in quality to that which flowed from the first well bored in the yard of the Terre Haute House. The analysis of this water was given in the report for 1869. The well on the bank of the river is now owned by J. S. Miller. If properly tubed the water would rise a great many feet above the general surface. The temperature is 81° F. It is a saline sulphur water, contains a large amount of common salt, some glauber and epsom salts, lime, magnesia and iron. There is a copious escape of carburetted hydrogen, carbonic acid and sulphuretted hydrogen. It possesses fine medicinal properties, and is particularly beneficial in diseases of the skin and some forms of rheumatism. Mr. Miller has erected a bathing house close by, where patients may enjoy the luxury of bathing and drinking the water.

IRON PYRITES. (BISULPHIDE OF IRON.)

This yellow, metallic looking mineral, is found in great abundance at Seelyville, where it occurs in bands or strata in coal L. It is readily separated from the coal and may be seen lying around Arbuckle & Budd's colliery in vast heaps and instead of permitting it to go to waste should be turned to profitable account by the manufacture of sulphur and sulphuric acid. Iron pyrites contains one equivalent of iron and two equivalents of sulphur, its symbol being $F_e S_2$ or $F_e S + S$. Its composition in 100 parts is: Iron 46.67, sulphur 53.33.

When iron pyrites is strongly heated it may be made to give up one half of its sulphur and the residue will be the copperas or green vitriol of commerce. The quantity of sulphur actually obtained from this mineral on a large scale does not exceed 13 or 14 per cent. The most important

use to which iron pyrites can be put is for the manufacture of sulphuric acid. This acid is in almost unlimited demand for many branches of manufacture and occupies the same relation to chemical technology that mineral fuel does to metallurgy or for the generation of steam.

In order to manufacture sulphuric acid from pyrites the mineral is calcined in a peculiarly constructed kiln over which is placed grooved rollers that serve to crush the ore that it may descend in fine particles over terraces to the bottom of the furnace which is maintained at a bright red heat. The sulphurous acid formed is conveyed into a leaden chamber where the usual arrangements are made to promote its conversion into sulphuric acid. One hundred pounds of pyrites will give about 140 pounds sulphuric acid. As a general rule, acid made from pyrites is contaminated with arsenic which renders the commercial article unsuited for many branches of manufacture. I was unable to find a trace of arsenic in the pyrites from Seelyville mines, and owing to the superior economy of manufacturing sulphuric acid from this mineral rather than from Cicilian sulphur, it is to be hoped that this notice will direct attention to this important industry.

Cicily sulphur of 95 to 97 per cent. is worth thirty-five to thirty-seven dollars per ton by the ship load at New York City; 100 pounds of this sulphur will, by good management, yield 280 pounds of sulphuric acid of 1.84 specific gravity; while 100 pounds of pyrites, costing almost nothing at the mines, will yield 140 pounds of acid of the same strength.

The residue, of per-oxide of iron, is now being utilized in England as a fetling for puddling furnaces and is said to answer the purpose better than any iron ore yet tried.

IRON ORE.

The bluish gray shales over coal L on the west side of Wabash river have disseminated through them irregular layers of clay iron-stone. Where the strata have been laid bare by the washing away of the soil on the sides of the

hills this iron-stone drops to the bottom of the ravines, where it is now found in quantities sufficient to justify its being gathered up and carted to the Vigo Blast Furnace, to be mixed with the Missouri specular ores and smelted into pigs. Locally the iron-stones are very abundant. The old Indiana Furnace in Vermillion county, when in blast, obtained its supply of iron ore from these shales.

TIMBER.

Vigo county contains the usual variety of trees found in this latitude. Many of the large black walnut and poplar trees have been converted into lumber and vast tracts of timber lands are annually cleared for cultivation, but a noble forest yet remains on portions of the uplands.

ANTIQUITIES.

There are two mounds of very moderate elevation in the southeast corner of the town of Maxville. Others may have been obliterated in the building of the town, and by the plow in cultivating the surrounding land. These, with the exception of a few that are reported along the Wabash, in Prairie town and Prairie Creek township, are all the mounds that I could hear of in the county. Mr. Pidgeon, in his work on antiquities, mentions some mounds near Fort Harrison Prairie, north of Terre Haute, but these have no doubt been leveled by cultivation.

AGRICULTURE.

This county is justly celebrated for its large tracts of fertile prairie and river-bottom lands. The soil belonging to these districts is for the most part a deep, black, sandy loam, rich in organic matter and all other elements essential for plant food. It is particularly well adapted for the growth of Indian corn and grasses, but produces all the cereals in very great perfection. While some of the hill or upland soil is derived from the loess and is of a buff colored, pulverulent nature, rich in lime, the prevailing constituent

is clay. This land, as a general rule, requires good drainage but produces well and is especially suited for wheat and clover.

More than usual attention is paid to the growing of fruit, and there are few farms to be seen without orchards. Some of the largest apple orchards in the State are to be found in the vicinity of Terre Haute.

CONCLUSION.

Before closing this report I desire to express my thanks to the citizens of the county with whom it was my good fortune to become acquainted, while prosecuting the survey, for the aid and courteous treatment so uniformly bestowed. For unusual attention and assistance I am under special obligations to Hon. Harvey D. Scott, Hon. W. K. Edwards, Hon. Joseph Gilbert, C. E. Hosford, A. B. Pegg, Wm. McQuilkins and Wm. Barrick, of Terre Haute; Jonas Seely, of Seelyville; J. S. Wyeth, Hartford; and Daniel Webster, of Webster's Station.

HUNTINGTON COUNTY.

This county is in the form of a rectangle, with the greater diameter lying north and south. It contains about 384 square miles. The physical features of the county are not marked by any prominent hills or elevated points, the general surface being slightly elevated table land that will hardly exceed 300 feet above the surface of Lake Erie. It is well watered by Wabash river and its tributaries, Little river, Salamonia river, Silver and Clear creeks, and a number of small branches which flow from the north and south into the principal stream. It will be seen, by reference to a good map, that Wabash and St. Mary's rivers rise in Mercer and Shelby counties, Ohio, on opposite sides of a narrow water-shed, and flow in the same direction, northwest, until the latter stream reaches a point near Fort Wayne, from whence it turns northeast and joins the Maumee, which flows northeast to lake Erie. St. Joseph river rises in Michigan, flows southwest to Fort Wayne where it also joins the Maumee river. This remarkable hydrographical feature of this part of the State has long attracted the attention of topographers and geographers. A very instructive map and account of this region was published by S. K. Gilbert, in the 1st vol. Geo. Rep. of Ohio. Prof. Gilbert attributes this water phenomena to at least two concentric elevated ridges, one near Defiance, in Ohio, and the other near Fort Wayne, these ridges being terminal moraines.

While there is much evidence presented by the course of the streams and other physiographical features of the country to sustain this view of the subject, there are yet some striking facts which seem to indicate that both St. Joseph

and St. Mary's rivers were once tributaries of Wabash river. The waters of Little river have their rise in a marsh seven miles southwest of Fort Wayne, and this swamp, in times of freshets, brings it into intimate connection with St. Mary's river. The old bed of Little river, where it emerges from the swamp, is as broad as the Wabash in the southeast corner of Huntington county and fully as broad as the St. Joseph at Fort Wayne. That the latter stream and St. Mary's river once formed a part of Little river and constituted the main source of Wabash river may be further inferred from their general parallelism to the courses of the streams that enter the Wabash from the southeast and northeast; Salamonia and Mississinnawa on the one side and Eel and Tippecanoe rivers on the other.

The only well marked evidence which I saw of terminal moraines in this county lies along both banks of Little and Wabash rivers. The large boulders which mark their boundaries are 40 to 50 feet above the beds of the streams. These boulders are very conspicuous above and below the town of Huntington. This county was named in honor of Samuel Huntington, one of the signers of the Declaration of Independence. Huntington is the county seat and is situated on Little river, two miles above its junction with Wabash river. It is built on the boulder terrace fifty two feet above Wabash river and Erie canal, which is here, by engineers' levels, eleven feet lower than Fort Wayne. It is a flourishing town with a population of between 3,000 and 4,000. Mr. Thomas Roche furnished me with the following list of manufactures and the value of manufactured articles for the currrent year; also, the amount of produce shipped, all of which speaks very well for the prosperity of the town and the resources of the county:

Taylor & Forsythe, plow handles, employ thirty hands and ship annually to the value of twenty thousand dollars.

C. E. Bryant, staves and headings, employs one hundred hands and do an annual business of seventy-five thousand dollars.

Henry Drover, spokes and bent wood, employs twenty hands and ships twenty-four thousand dollars worth annually.

W. J. Campbell, cigar manufacturer, works five hands and produces eight thousand dollars worth annually.

Maffett & Roche, foundry, do an annual business of sixteen thousand dollars.

Hassin & Son, shippers of butter and eggs, sell to the amount of forty-two thousand dollars.

Arnold, Thomas & Co., flouring mills, manufacture twenty thousand dollars worth annually.

Adam Renauer, furniture, employs twelve hands and sells annually fourteen thousand dollars worth of goods.

F. Kapp, furniture, annual sales five thousand dollars.

E. T. Taylor, boot and shoe manufacturer, ships to the value of twenty thousand dollars and gives employment to thirteen hands.

Snider & Son, work four hands and sell annually six thousand dollars worth of boots and shoes.

I. Mangris, employs six hands, sells boots and shoes to the amount of nine thousand dollars.

W. Fisher works five hands in the boot and shoe business and does an annual business of seven thousand five hundred dollars.

Thomas Slack & Co., deals in lumber to the amount of fifteen thousand dollars per year.

Annual shipments from Huntington:

237,000 bushels of wheat.

176,000 bushels of corn.

53,000 bushels of flaxseed.

79,000 bushels of oats.

8,000 bushels of clover and grass seeds.

30,000 hogs.

B. H. Reynolds shipped, on commission, 800,000 wagon spokes and 400,000 feet of hickory and oak lumber.

Warren and Mt. Etna, on Salamonia river, in Salamonia and Polk townships, Markle on Wabash river in Rock creek township, and Antioch, in Dallas township, on the

Toledo, Wabash & Western railroad, are all towns of considerable importance.

The Toledo, Wabash & Western railroad, follows along the banks of Little river and crosses to the south side of Wabash river a short distance below Huntington, to cut off a considerable bend which the latter stream makes to the north, but re-crosses the river at the western edge of the county and continues along its shores to Attica, in Fountain county.

GEOLOGY.

The only rocks exposed, in place in this county, are of paleozoic age and belong to the Niagara epoch. The erratic material composing the glacial drift, rests immediately upon the Niagara, and is succeeded by clay, without organic remains, which may or may not belong to the loess. On this clay we have the recent soil accumulations.

The most eastern out-crop of the Niagara, in the county, is at Markle on the Wabash river. The rock here is quarried from the bed of the river. It has a blue-gray color, irregular fracture, is in four to six-inch layers, and in this part of the county is a favorite building stone. The section exposed in the river bank at Markle, is:

SECTION AT MARKLE:

	Ft.
Drift	6
Buff magnesian limestone, schistose and cherty, and contains a few Niagara fossils	10
Bluish gray thin bedded limestone, in bed of Wabash river	3?
	19

The strata have a local dip of 20° southeast. The crop may be followed for two or three miles up and down the stream. The analysis of this stone shows it to be composed of:

Moisture	.75
Carbonic acid and combined water	48.50
Insoluble matter	2.25
Iron and alumina	2.50

Lime	37.56
Magnesia	7.58
Sulphuric acid	.27
	99.37

The beds used for masonry can only be quarried during periods of low water when the current can be turned from it by inexpensive temporary dams. Another crop of this stone is seen along the Salamonia at Warren and at points above and below. Half a mile east of Warren, John A. Lewis has a lime kiln situated in a shallow ravine on the crop of the porous, buff magnesian limestone. In quarrying he has gone down only six feet. The stone is schistose and false bedded, which gives it the appearance of having a strong dip to the southwest. Analysis of

Limestone from John A. Lewis' quarry:

Moisture	.75
Carbonic acid and combined water	50.25
Insoluble matter	1.50
Iron and alumina	3.20
Lime	30.80
Magnesia	10.45
Sulphuric acid	.06
	97.01

One mile below Warren, Elisha Christman has a lime kiln, and is using the stone from a crop on the bank of Salamonia river. Six to eight feet of stone is seen above the bed of the stream. Similar rock is seen again near the grist mill at Bellmont.

At the bridge over Wabash river, one and a half miles south of Huntington, there is a crop of Niagara exposed, sixteen feet above the bed of the river. This stone was used in the bridge abutments, but already shows signs of rapid decay by crumbling under the influence of water and frost. The principal part of the bed is an earthy limestone, and presents the appearance of a very good hydraulic stone. Its composition in 100 parts is:

Moisture	.40
Carbonic acid and combined water	35 10
Insoluble silicates	32.50
Iron and Alumina	1.90
Oxide of manganese	.40
Lime	24 92
Magnesia	4.32
Sulphuric acid	.14
	99.68

It will be seen that this stone differs from the Markle stone in the large amount of insoluble silicates which it contains, 32.50 per cent., the former only having 2.25 per cent. As before stated, it will make a very good hydraulic cement but is totally unsuited for masonry where durability is desired.

The greatest development of the Niagara is seen along the banks of Little river above and below Huntington. The most easterly crop is on John McCarty's land on section 18, township 28, range 10, about three and a half miles from Huntington. From this point east it remains covêred by drift and is penetrated at the depth of eighty-eight feet by the Fort Wayne well. Lime kilns have been established all along the crop and the burning of lime constitutes one of the chief industries of the county.

Thirty one kilns were in aotive operation making caustic lime at the time of my visit. Eight of the number are perpetual kilns, the remainder are occasional kilns which require to be completely discharged and cooled before re-filling. The companies are here given in the order of their location on the river, commencing with the one farthest up the stream. The number of bushels of lime annually burned is also given.

Name of Owner or Firm.	Number of Kilns.	Cords of Wood Consumed	Bushels of Lime Produced.
John McCarty	1	400	20,000
A. Bower	2	460	23,000
Foster & Fulton	3	1,000	50,000
E. S. Wheeler	2	1,200	57,000
Berry & Booser	2	1,100	53,000
Hawley & Bro.	2	1,200	59,000
A. Beck	3	1,800	90,000
Smith & Morton	2	600	30,000
James Lillie & Co.	4	1,900	100,000
M. Baltus	6	1,900	100,000
Pound & Co	2	400	20,000
Mollering & Son	2	300	15,000
Total	31	12,260	617,000

It will be seen by this table that the annual make of lime amounts to about 617,000 bushels and the consumption of wood to 12,260 cords; being an average of nearly 400 cords of wood and 20,000 bushels of lime per kiln, and an average of 50 bushels of lime for each cord of wood consumed.

This lime is held in high estimation and meets with a ready market not only in Indiana, but in Ohio and Illinois, as well. The composition of the stone used at the respective kilns on Little river is given in the following table:

TABLE OF ANALYSES OF LIMESTONES FROM HUNTINGTON COUNTY.

NAME OF OWNER.	Moisture at 212 degrees, F.	Carbonic acid and combined water.	Alumina, with some oxide of Iron.	Lime.	Magnesia.	Sulphuric Acid.	Insoluble Matter.	Oxide of Maganese.
Fert Wayne Co., lower quarry......... ....No. 1	.25	45.25	18.00	26.90	3.96	.27	3.65	
Hawley Bros...No. 2	.50	49.52	8.25	31.92	9.58	.54	.50	
One mile below Markle..............................No. 3	.75	48.50	2.50	37.54	7.56	.27	2.25	
Hawley's ....No. 4	.30	49.20	2.50	33.44	12.61	.34	1.50	
Warren road, near bridge ....No. 5	.40	35.10	1.90	24.92	4.32	.14	32.50	.40
Amos Bowers..No. 6	.35	45.15	18.50	31.08	4.32	.30	.50	
Berry Bros..No. 7	.80	47.20	9.00	29.12	12.43	.27	1.00	
McCarty ....No. 8	.60	50.90	11.50	27.44	8.28	.00	1.25	
Drover..No. 9	1.00	58.00	4.50	17.64	18.20	.00	.60	
John A Lewis ....No. 10	.75	50.25	3.20	30.80	10.45	.06	1.50	

The quality of the burnt lime is mainly due to the constituents of the limestone from which it is made. When the stone is principally composed of carbonate of lime the resulting lime is what is called by the masons "fat lime" or quick setting. But if the stone is a dolomite, composed of equal equivalents of carbonate of lime and cabonate of magnesia, the resulting lime forms a short, thin pulp with water and is termed "poor." For ordinary mortar, fat lime is objectionable on account of the rapidity with which it sets and becomes too hard to enter into close combination with the brick. Therefore, a medium quality of lime, termed "slow setting," is sought for, since it will yield a mortar that when spread over a large space will give the mason an opportunity to adjust a number of bricks before it commences to set. This property is found in lime where the magnesia does not form too large a per cent.

From the table of analyses, it will be seen that the composition of the limestones in this county varies as regards the amount of insoluble silicates, alumina and magnesia, which they contain, nor is it fully understood why these substances, when present in quick-lime in proportions that are quite variable, give to it hydraulic properties, so that, with our present chemical knowledge of the subject, one is at a loss, in the absence of actual practical tests made of its binding qualities, to decide where the mortar ceases to be air-setting and becomes hydraulic or water-setting.

Nos. 1, 2, 3, 4, 6, 7, 8, 9 and 10, yield good but slow air-setting caustic lime. No. 5 will undoubtedly give a lime that will have hydraulic properties, or set under water.

The limestone, which is considered the best for making quick-lime, is a buff, porous stone containing large quantities of casts of *Pentamerus oblongus*, *Amphicoelia costata*, *Rhynchonella sp?*, *Orthis annulatum*, *O. erebescens*, *Chonophyllum niagarensis*, *Favosites niagarensis*, *Halysites catenulata*, *Fenestella sp?*. These fossils are particularly abundant at McCarty's quarry. *Pentamerus oblongus* is especially conspicuous and gives the stone the appearance of a breccia.

The stone lies so close to the surface that very little

stripping is required in order to reach the layers suitable for lime.

The following section will show the depth to which the stone has been worked at the quarries and the amount of earth that has been removed.

SECTION OF M. BALTUS' QUARRY:

	Ft.
Soil	2
Schistose buff magnesian limestone	6
Best stone for burning	2
Little river.	

SECTION AT BERRY BROS.' QUARRY:

	Ft.
Surface soil	3 to 4
Friable magnesian limestone	9
Thick bedded limestone	3
Little river.	

SECTION AT HAWLEY BROS.' QUARRY:

Soil and clay.	
Buff porous magnesian limestone	10 to 12 ft.
Bed of Little river.	

SECTION AT LILLIE & CO.'S QUARRY:

	Ft.
Surface, black mold	1
Magnesian limestone	7

The rock at the above quarries lies in waves, and is peculiarly characterized by false bedding, which sometimes gives the appearance of a disturbed strata, dipping in various directions at a high angle. There are quarries on the left bank of the river, where the buff magnesian limestone, so famous for the good lime which it yields, is mixed with, and sometimes replaced by, a bluish earthy hydraulic limestone, resembling the stone at the bridge over Wabash river. Considerable money has been spent in trying to make of it a marketable lime, and to introduce it as a building stone, but in both instances it has proved comparatively worthless; it may, however, by judicious selection, be used for the manufacture of hydraulic cement.

Just along the west edge of Huntington, quarries have been opened at several places, running north from the river, for flagging and building stone. At the most southern opening, about one hundred yards from the river, we find:

Loose chert	6 feet.
Blue flag-stone, beds in three inch layers	6 feet.

The dip at this quarry appears to be 8° in the direction of 40° east of south. The chert is in large detached masses and mixed with buff magnesian limestone. North, seventy yards, at another quarry, the buff magnesian limestone is free from chert, but is schistose and false bedded, with an apparent dip of 20° at the south part of the quarry, but going back some ten yards the apparent dip is 37° S. 40° E. Half a mile down the stream, the rocks at the river edge dip about 80° S. 70° E. At the Drover quarry, owned by Mollering & Co., a large opening has been made by quarrying stone for lime. The rocks are false bedded and appear to dip in every direction from the centre of the quarry.

The surface rocks, where excavations commenced and went to the depth of 20 feet, is buff magnesian, coral bearing limestone. In some parts of the quarry there are masses of *Favosites niagarensis* so large as to lead at once to the belief that the entire bed of stone was derived from an ancient coral reef. The great disorder of the strata, mainly due to false bedding or peculiar arrangement of the material constituting the present rocks, has led many to infer that this irregularity was due to earthquake or volcanic action. This is the more deceptive since the apparent elevations have their surfaces capped with enduring beds of chert or impure flint, and along the local waves in the strata stand in elevated knobs which fancy has construed into volcanic cones. Huntington is located on one of these flint ridges and the locality was known to the Indians by the name of "*We-pe-cha-an-gan-ge*" or flint place. The flint of this locality was of great value to the Indians

as the material of which they fashioned their arrow points, spear points and flint knives.

At dam No. 1 across Wabash river, two miles below Huntington, the Niagara rock appears along the left bank of the stream and served for one of the abutments of the dam. The beds are thin, cherty and much weathered on exposed edges. The rock forms the bed of the river and presents a vertical face ten and a half feet in hight on the left shore, while in the bottom on the opposite side of the river it is entirely replaced by the drift. A few feet below the dam there is a slight anticlinal axis, the dip being 4° S. E. on one side of the crown and 4° N. W. on the other.

Col. Milligan's quarry, just below Huntington on the bank of Little river, has been leased by a practical quarryman, Charles Krock, and he is taking out some of the best looking stone for flagging and mason work to be found in the neighborhood. The stripping is quite light, and the section obtained, shows:

	Ft.	In.
Soil	1	00
Buff, rubble, chert, mostly loose	1	06
Buff rubble, good	2	06
Flagstone	0	02
Flagstone	0	05
Building stone	0	08
Building stone	0	09
Bed of Little river.		
	7	00

On Wabash river, about one mile northwest of Antioch, Joseph Leidy has opened a quarry to procure stone for the abutments of a new bridge to be built across the river where the road leading north from Antioch crosses it. The stone is quarried at a crop in the river bank and furnished the following section:

	Ft.
Earth stripping	1
Buff, schistose, magnesia limestone	3
Flint strata 1 to	2
Buff, magnesian limestone, some blue spots and bands, principal rock used	15
Bed of Wabash river.	

The beds are very irregular, with an apparent dip of 8° to the southwest. On the opposite side of the river and at Loon creek, similar rock is seen. The entire thickness at the crop is twenty feet, and the apparent dip is 20° northeast. This stone was quarried and used in the construction of locks on the canal, but can not be considered a durable stone. Near this old quarry and on section 22, township 28, range 8, there is a strong chalybeate spring. It rises up above the surface of the ground and flows over the side of the gum curbing in a bold stream; it is strongly charged with iron, and is cool and pleasant to the taste. The water possesses valuable medicinal properties, is close to the thriving village of Antioch on the Toledo, Wabash & Western railroad, and might be made a place of resort for invalids who require a mild tonic. An additional attraction may also be found in the saline sulphur water, on section 14, township 28, range 8, scarcely a mile distant from the chalybeate spring.

The sulphur water flows from an artesian well bored for coal oil on the bank of Silver creek. No record could be found of this bore, but it is supposed that the water comes from a depth of about 600 feet, and flows out at the top of a wooden pump stock, four or five feet above the surface. Judging by the taste, it is strong in chloride of sodium and other mineral salts, and emits a strong oder of sulphureted hydrogen mixed with marsh gas, carbureted hydrogen. The existence of the latter gas, in the boggy places along the creek, led to the selection of this locality as one most likely to furnish oil, from the well known-fact that carbureted hydrogen usually accompanies the oil in the famous wells on Oil creek, in Pennsylvania. In this case, however, no oil was obtained. Anywhere in the marsh near the well, if a stick is run down into the mud and vegetable matter, carbureted hydrogen will escape, and if touched with a lighted match takes fire and burns. This well is peculiarily interesting, since it lies almost mid-way between Fort Wayne, where a well was bored to the depth of 3,000 feet, and Wabash, where a well went to the depth

of 2270 feet, neither of which found water that would rise to the surface.

It will be seen from the foregoing remarks, that the only stratified rocks found in the county crop in a few localities along the streams, and that while they are eminently suited for the manufacture of quick-lime, it is only in rare instances that layers are found at all suitable for masonry, where durability is considered of prime importance. The Niagara, in this State, is not metalliferous, it does not even furnish notable quantities of iron-ore. Nevertheless, some years ago there was considerable excitement raised about the reported existence of gold in the rocks at the Drover quarry, now owned by Mollering & Co. Specimens of the reported gold ore were taken to New York, by Mr. Backus, and they were reported by some one to yield $158.00 to the ton. Stock to the amount of $10,000 was sold and with the money thus raised, the company erected a mill and purchased the necessary machinery for crushing the rock and saving the precious metal. Unfortunately for the success of the enterprise, the rock, as any intelligent geologist could have told them at a glance, proved totally barren of precious metals, and all the company could realize after spending much money, was the value of the, to them, useless machinery.

Mr. John Roche pointed out to me the exact spot where Mr. Backus obtained his specimens and the mineral which he mistook for gold. It proved to be iron pyrites partly decomposed on the surface and filling isolated cavities in the cherty, magnesian limestone.

GLACIAL DRIFT.

The drift covers the entire county, and can not be less than 100 to 130 feet thick over a great portion of the table-land. The upper portion is composed of irregular beds of sand, clay and gravel. Boulders and hard plastic clay lie

at the base. The larger boulders, "Roches moutonnees," lie along both shores of Little river and Wabash river at an elevation of 40 to 50 feet above the streams. They are particularly abundant above and below Huntington on the right bank of Little river. Their surfaces are scratched and grooved but I was unable to find glacial scratches on the stratified rocks where they are exposed to view. This may, in part, be due to the fact that no fresh surface of the upper layers were seen, and the readiness with which the Niagara weathers, would soon obliterate all traces of such marks. From the manner in which the boulders lie along the borders of Little river, one is led to the conclusion that the stream has cut its way between two lateral moraines. A very large granite boulder, weighing many tons, lies in the bed of Little river three and a half miles above Huntington, which, from a fancied resemblance in shape to a saddle, has received the name of "Saddle Rock." This boulder rests immediately on the Niagara which is here seen in the bed of the river for the last time as you ascend the stream, and is not again found above the surface in an easterly direction before reaching the borders of Ohio. The large beds of sand found in the upper part of the drift are particularly valuable in this part of the State since they furnish the only source from which this essential ingredient of good mortar can be had. There is a very large deposit of sand in the northwest border of Huntington. It is ten or twelve feet thick and the lines of deposition present the characteristic features of what is termed in rock strata "false bedding." The sand from this pit is held in high estimation by the masons and plasterers, and finds a ready market.

ANTIQUITIES.

Though the present site of Huntington and the "Forks of the Wabash," as the junction of Little river with that stream was familiarly called by the early settlers of the county, was the favorite abode of savages, yet, strange to

say, no traces of the works of the pre-historic mound builder are found in the county, except along Salamonia river, in the southeast corner, opposite Warren, where, on a high eminence in the bend of the latter river, there are two mounds. The first one visited is at Daniel Adsits. It is about twenty-five feet in circumference and six feet high. A slight excavation had been made into the top, but so far as could be learned no relics were found. there is a shallow trench completely encircling it. From the top the view overlooks the Salamonia and its fine fertile bottoms. The other mound is about a quarter of a mile to the northwest, and in a cultivated orchard belonging to John D. Jones, and near his barn. This mound has been nearly destroyed by the plow, and I was unable to learn that it possessed any peculiar features, or contained any relics. Mr. Jones informed me that he had, from time to time, picked up on his farm, stone axes, pipes, flint arrow and spear points, but could give no special account of the existence of other mounds. Though I followed Salamonia river for many miles above Warren, and made repeated inquiries about mounds, I could not learn of any others in the county.

TIMBER.

This county was originally covered with a fine forest, but clearing the land for farming purposes and the conversion of trees into lumber has greatly reduced its area and stripped it of many of its finest representatives. Among the principal forest trees are white oak, poplar, black walnut, beech, ash, sugar tree, burr oak, red oak, elm and some cottonwood on wet land. On the road to Silverville, three and a half miles.northwest of Huntington, I measured a white oak tree that proved to be twenty feet and three inches in diameter, four feet from the ground.

AGRICULTURE.

The county may be divided into upland soil and bottom-land soil. The former is situated on the level plains which

lie from 80 to 120 feet above the river and creek bottoms. It is of every variety, from stiff yellowish clay to sandy loam and black muck. This land is generally underlaid by a stiff, tenacious clay which retains the surface water and gives rise to extensive marshes. These marshes, until drained by ditches, were filled with aquatic plants, and were impassable to horsemen. I was taken by Mr. John Roche to his farm, located on the site of a large swamp, the former home of beavers, and the dams which these industrious animals had constructed across narrow necks of the swamp, in order to confine the water and protect their homes against the dangers of drouth, are still to be seen. When drained this land is unsurpassed by any in the county for corn, wheat, oats and grasses. The loose, porous, buff soil, on the table lands, is a clayey marl and may be ranked as the best character of land for producing large yields of wheat and clover. The river and creek bottoms are everywhere arable lands, and produce fine crops of grain and grass. The immense swamp, which lies along the southeastern border of the county has been, in a great measure, ditched and drained by the energy and enterprise of Mr. John Roche. The reclaimed soil is a deep black, sandy loam, and though the season had been remarkably wet, I saw as good corn growing on it as could be found on land originally dry.

All the clayey land in the county will be greatly improved by under-draining, and no better investment can be made by farmers than one which is to provide tile for a thorough system of under-drains. Where the land has been long in cultivation the under-drains should be followed up by an annual application of fertilizers to the soil, such as will return to the land the plant food which has been removed by carting off the crops. Taken altogether the lands of Huntington county take a very high rank for fertility.

CONCLUSION.

I desire in this place to return thanks to the citizens of

the county for the courtesy uniformly extended to me while making the survey. My obligations are especially due to John Roche, Thos. Roche, Hon. A. H. Shafer, M. D., Robert Simonton, W. W. Hawley, Maj. J. W. Purviance, Alfred Moore attorney at law, W. McGrew First National Bank, Daniel Hitch, Hon. Mr. Sayler attorney at law, J. R. Slack attorney at law, T. L. Lewis county clerk, S. Emley sheriff, and L. J. Day recorder.

In consequence of the great length of the report for 1875 and the small sum appropriated for the public printing, my observations in Decatur, Hamilton and Madison counties will have to be witheld until the publication of the next report.

SPECIES OF FOSSIL MARINE PLANTS

FROM THE

CARBONIFEROUS MEASURES.

COLUMBUS O., 10 April, 1876.

DEAR SIR: Please find herewith a short report on the specimens of marine plants of the coal measures which you have sent to me for examination. To the description of the species I have added a few remarks on their relation and their distribution. A number of specimens, partly referable to the three first species, were communicated by Mr. J. F. Miller, of Richmond, Indiana. The fifth species is described from one specimen from the coal measures of Illinois, found with others of the same kind, by Mr. I. H. Southwell, of Port Byron, Illinois, to whom the communication is credited.

Respectfully Yours,

L. LESQUEREUX.

TO PROF. E. T. COX,

State Geologist of Indiana.

The occurrence of fucoidal remains or of fossil marine plants, in the coal measures, is extremely rare. Indeed it is questionable if any species of this kind has ever been discovered in the carboniferous formations of Europe. In this country one species only has been described, in 1866, (Trans.

Amer. Phil. Soc., vol. xiii, pp. 313-328, pl. vii,) from specimens found in a thin bed of limestone, occupying the place of the millstone grit, opposite Wurtemberg, on Slippery Rock creek, a branch of the Coneconessing river in Pennsylvania.* The species is related by its characters, to the so called and well known *Fucoides Caudagalli* of the middle and upper Devonian, and therefore does not represent ancient types, like those which are described here, and which recall the oldest forms of marine plants, those of the Silurian, even of the lower divisions of this formation, the Calciferous sandstone of New York.

It may seem of little importance to have plants of this kind described and figured in a geological report, but as geologists have to consider, for the determination of the age of the strata of our earth, the remains of plants and of animals which, preserved in their compounds, may determine by their nature, the position of valuable deposits of minerals, even mere fragments of these organisms become important for their researches. And when fossils are found, which not only represent new types of plants or of animals, but which are remarkable by their presence in a formation where nothing like has ever been found, the discovery is indeed worth recording in the annals of geology, and gives to the report where they are described a wide and general interest.

DESCRIPTION OF GENERA AND SPECIES.

Genus, PALEOPHYCUS. Hall.

Frond expanding from a cylindrical simple axis, enlarging in ascending by repeated forking of the branches, (dichotomy); branches cylindrical or slightly flattened by compression, either simple or anastomosing by divisions in right angle, obtuse or obtusely pointed, sometimes umbonate (bossed), surface smooth or dotted.

This genus, established by Hall, in Paleontology of New

*It is quoted under the name of *Phytophycus marginatus*, in Schimper's *Vegetable Paleontology*, where all the fossil plants known to our time, (1875), are described, as the only species of marine plants positively known from the coal measures.

York, Vol. I, p 7, is here somewhat modified according to the characters of the species which I refer to it. It is the equivalent, by its name at least, of the old genus *Fucoides*, of Brongniart, which, used as it was originally for the description of marine plants of far different characters, even of Graptolithes, has become too vague and uncertain for classification. Modified as it has been recently by Schimper, it represents merely species of the type of *Fucoides antiquus*, Brgt., or *Buthotrephis antiquata* ? Hall, and also species of *Paleophycus*. This last generic name, however, was proposed before this modification, and is worth preserving for the American species of marine plants answering to the character of the genus, and which are of a type widely represented in the old formations of this continent, and rarely recognized in Europe until now.

1. PALEOPHYCUS MILLERI. Spec. nov. Pl. i. Figs. 1-3.

Frond (whole plant) erect, enlarging in ascending by subdivision of its branches, forking in an acute angle of divergence; branches cylindrical or slightly flattened by compression, apparently of a coriaceous substance, when living, gradually increasing in thickness from the base to an obtuse, sometimes umbonate point, irregularly split across or slightly strangled by deep lines in right angle to the axis; surface punctate with projecting obtuse dots or very small warts in more or less distinct rows, sometimes smooth at the upper surface by abrasion.

The specimens here figured were communicated by Prof. E. T. Cox, but later I obtained, by the kindness of Mr. J. F. Miller, Superintendent of 1st Division, Pittsburg, Cincinnati & St. Louis railroad, a number of others, among them one branch of larger size, more distinctly and repeatedly dichotomous than those of the figures. The branches vary from one-half to two centimeters in thickness; a cross section of the largest measures two centimeters in the horizontal direction, and one and one-fourth centimeters vertically, it being somewhat flattened. As seen in figure 1., they greatly differ in size, even at their point of separation, the branch

of the right side of the specimen having one of its divisions twice as large as the other. The same branch proves that the splitting and strangling of those cylindrical remains is not a noticeable or permanent character, as one of the branches only, is cut across in its lower part, while the larger one is entire and smooth. The same might, perhaps, be said of the dotting of the surface, but it is mostly distinct on the declining borders of the branches, while it is generally effaced upon their convex surface, more exposed to abrasion. In a few of the divisions, which are flattened, the points are scarcely discernable. Their distribution, in more or less distinct rows, is marked upon fig. 1^a, doubly enlarged, and their form pointed on one side or concave in the center, as seen in the more enlarged fig. 1^b. The bossing, remarked figure 3, represents abortive branches, and can not be considered as a specific character in algæ of this generic division. The large specimen communicated by Mr. Miller has forking branches, one of them merely umbonate, and its surface is distinctly dotted. The tumescence is remarked in the middle of fig. 2, as well as near the top of fig. 3.

This species is related to *P. tubularis*, Hall. loc. cit., vol. 1, p. 7, pl. ii, figs. 1 and 2, and especially to an undescribed fragment figured in the same volume, pl. xxi, fig. 3, the essential difference separating this species from that of the Calciferous sandstone of New York, being the dotted surface, the more regular divisions in an acute angle of divergence, and their curved direction.

2. Paleophycus gracilis. Spec. nov. pl. i, figs. 4, 5.

Frond, small, enlarging upwards by multiple dichotomy; branches cylindrical, forking in a more open angle of divergence, slender, gradually decreasing in thickness from the base up to an obtuse point, easily split in right angle to the axis, sometimes slightly punctate, generally smooth.

The whole frond, as represented, fig. 4, is a little more than three centimetres long and not quite as broad in its upper part. The thickness of the main stem, as low as it

can be seen, is two millimeters, decreasing upward to the obtuse point of the branches, scarcely one-half millimeter broad. The branches and stems are exactly cylindrical, apparently fragile, broken in fragments, imbedded in the clay, generally smooth, sometimes slightly irregularly dotted. The surface character of the branches is seen in the enlarged figures 4[a] 5[a] 5[b]. This punctation seems to refer this plant to the former as a mere variety; it is, however, positively distinct and separated by its harder consistence, indicated by the cylindrical preservation of its branches, by its mode of division in repeated forkings at a more open angle of divergence, by the gradual attenuation of the divisions and by its size. A relation of the same kind exists between two species of marine plants,—*Fucoides antiquus*, Brgt. and *F. gracilis*, Hall, which Goppert considers as mere varieties of the same.* Without taking into account the great difference between the size and form of the branches, as figured by Goppert, it is certainly hazardous to unite in one species, fragments of marine plants of Europe and of the United States, in comparing them from mere figures. It seems, however, evident that *Buthotrephis antiquata*, Hall. loc. cit., pl. ii, fig. 6, of the Calciferous sandstone, and *B. gracilis*, Hall., pl. xxi, fig. 1, of the Trenton limestone, are the same species. Both figures of Goppert, loc. cit., are, however, far different.

3. PALEOPHYCUS DIVARICATUS Spec. nov.

Frond, round in outline by the flattening or compression of the branches in the vertical direction all around the central axis; branches irregularly forking and anastomosing by cross divisions, nearly equal in size in their whole length, obtusely pointed, surface smooth.

This species differs from the first by its narrower, more slender branches, not falcate, rarely forking, but diverging all around the base, joined together by divisions, anastomosing at right angle, and smooth. The general appearance is quite different. It is represented by two specimens in

*Goppert. Uebergang's Flora, p. 81, pl. 1, figs. 1 and 2.

the possession of Mr. Miller, and these were received too late to be figured, or, after the preparation of the plates. The species is, however, easily recognized by the characters indicated above. It is comparable by its form, the direction and mode of anastomosing of the branches, to *Phytopsis cellulosa*, Hall., which, according to Emmons, is a Polyp; but we do not see, in the cross section of the branches of this species, anything like transverse parietes, or stellate and cruciform cells, as in the New York *Phytopsis*, but an homologous, amorphous compound, like that of the former plants, and characters which force me to consider this organism as referable to the same genus, if not as a variety of the first of these species. Indeed I should have considered it in that way, if any part of the specimens which represent it had shown traces of dots upon their surface. The anastomosis of branches in right angle is not a specific character, as seen from *Paleophycus tubularis*, Hall., which, in one specimen, has the branches simple and dichotomous, while the other indicates a disposition to anastomosis in right angle, by branches and branchlets.

HABITAT. All the specimens representing the three species described above, were found imbedded in concretions of carbonate of iron, in a bed of clay over coal L, on the banks of a branch of Salt creek, one mile south of Bruilette creek, Vigo county, where Prof. Cox collected in great abundance, *P. Milleri* and *P. gracilis*. The specimens of Mr. Miller are from the same locality, or about; they represent *P. Milleri* and *P. divaricatus*.

Genus ASTEROPHYCUS, *Lesqrx.*

Frond or rhizoma, expanded at its base in star-like divisions from a central axis, (broken); divisions oblong or obovate, rounded or emarginate at the outside border; surface wrinkled in the length.

4. ASTEROPHYCUS COXII, *Spec. nov., pl. 2, figs.* 1, 2.

The specimen, one-half of which is represented upon the plate, bears five flattened star-like bodies, similar to each other, placed in two rows, three on one side, two on the

other, those of the corners being opposite. The largest of them is twelve centimeters broad between the points of the opposite branches, the smallest only six centimeters, and the divisions, in all, are in five or six, one of them being doubled, as in fig. 2. From the superposition or doubling of one of the branches, it seems as if they had been growing successively by the development of new ones, as far as the vegetable increased in size, or by the reproduction of smaller, nearly cylindrical projections, appearing either upon the original rays, or outside and between them, as seen in figs. 1ᵃ and 1ᵇ. These younger shoots do not preserve their cylindrical form in growing, but enlarge and enter into the composition of the plants as new divisions. The surface of all the rays, when fully developed, is deeply, irregularly wrinkled in the length. The young branches are slightly and transversally rugose, as in fig. 1ᵇ. The central part, raised up as a columnar support, or as a cylindrical base of a frond, is broken a little above the point, where it enlarges in its connection to the rays.

As the fracture of the axis is exactly the same upon all the specimens under examination, just above the star-like division, it might suggest the idea that they represent an over turned plant, the axis being a rhizoma penetrating the ground, and the rays showing the lower part of a flower-like expansion. In that way the organism would be comparable to some species of geasters (star mushrooms), as seen upon the ground with their receptacle open and divided star-like, in five or six rays, after the detachment of the globule. Two specimens from Kentucky, communicated by Rev. H. Herzer, of Louisville, and representing the same species with somewhat varied forms, contradict this supposition. The largest one, eighteen centimeters wide, shows an upraised cylindrical axis or base of a frond, broken at the column, like the specimen from Indiana, dividing around from its sloping base in numerous cylindrical branches, varying in thickness from one to two centimeters. These branches are simple, not divided, depending all from the main axis which they join by the narrowed upper end,

enlarging downward to the middle, and thus generally spindle shaped. These are the characters of a fucoidal plant, whose axis is the broken column of a frond, to which the divisions around serve as a support, the true plant, which may be merely cylindrical in its development, being as yet unknown. In another specimen from the same locality, the subdivisions, passing nearly horizontally from the axis, are in six thick branches, placed star-like around the central axis, as in the specimens which are figured pl. ii. They bear from their under surface numerous cylindrical rootlets, which, traversing the whole thickness of the stone, three centimeters, appear upon the under face of the specimen like small circular protuberances, three to five millimeters thick. This shows that these plants figured in this natural position with their upper surface exposed to view, represent an expansion of the column to which, and underneath, are attached the rootlets, which, penetrating the sand, served to fix the plants more firmly to the bottom. It is probable that careful researches in the strata where these vegetable remains have been found, will cause the discovery of the upper part of the plants or fronds attached to the rhizomes. These, however, may have had long supports, as stipes, if they were not merely simple and of the same cylindrical form and size in their whole length. The base of some species of large algæ of the present time have a configuration similar to that of these fossil remains. Marine plants have not true roots; they are attached to the rocks by mere expansions of the base of the fronds, either divided in various ways, sometimes star-like, or flat and expanding around, taking firm hold of the rocks by adhesion of the lower closely applied surface, or penetrating the sand by cylindrical branches like rootlets.

A peculiar fact which may be due, perhaps, to the vegetation of these marine plants, is the exactly similar nature of the rocks wherein the Kentucky and the Indiana specimens are found imbedded. It is a kind of very hard, siliceous quartzite, of whitish color, giving fire by the hammer's stroke, like silex. It is a well known fact that though the

algæ do not take their food from the rocks to which they adhere, they often modify the composition of these rocks by their growth. Their influence, either by their vegetation or their decomposition, is still more marked upon the sand or any soft substances surrounding them. These modifications are as yet imperfectly recognized by chemistry. In the present case, these algæ seem to have covered the sandy bottom in immense numbers, as a single specimen, about sixty square inches, is nearly fully covered by five and one-half of the plants here described.

For the analogy of these remains with others known in a fossil state, there is a point of comparison in some kinds of vegetables figured by Prof. Hall., in the New York Paleontology, vol. 2, pl. x, fig 9[a]. They are not described, but considered by the author as roots of *Buthotrephis.* One of them represents a cone with the point turned downward, and wrinkled in the length, expanding and flat in the upper part, like the mouth of a funnel. If this represents the support of a fucoidal plant, the expanded limb should be the base adhering to the bottom, and the cone the axis, either entire and therefore a whole plant, or broken and separated from the frond, as in the remains described above. In that way this organism would have a kind of affinity to this species, and still more to the following.

Habitat. In a sandstone connected with the coal beds of the Cut-off of the Wabash, near New Harmony, Indiana, discovered by Prof. E. T. Cox. The specimens communicated by Rev. H. Herzer, are from Rock Castle, Kentucky. Lower carboniferous.

Genus CONOSTICHUS, *Lesqrx.*

Rhizome(?) obconical, formed of successive rows or disks, diminishing in size from the base to the point of the cone, regularly cut on the borders, in short, obtuse, inflated lobes, corresponding in their divisions.

5. CONOSTICHUS ORNATUS, *Spec. nov. pl.* 1, *fig.* 6.

This peculiar cone shows a series of six successive layers, increasing in diameter from the upper one toward the base

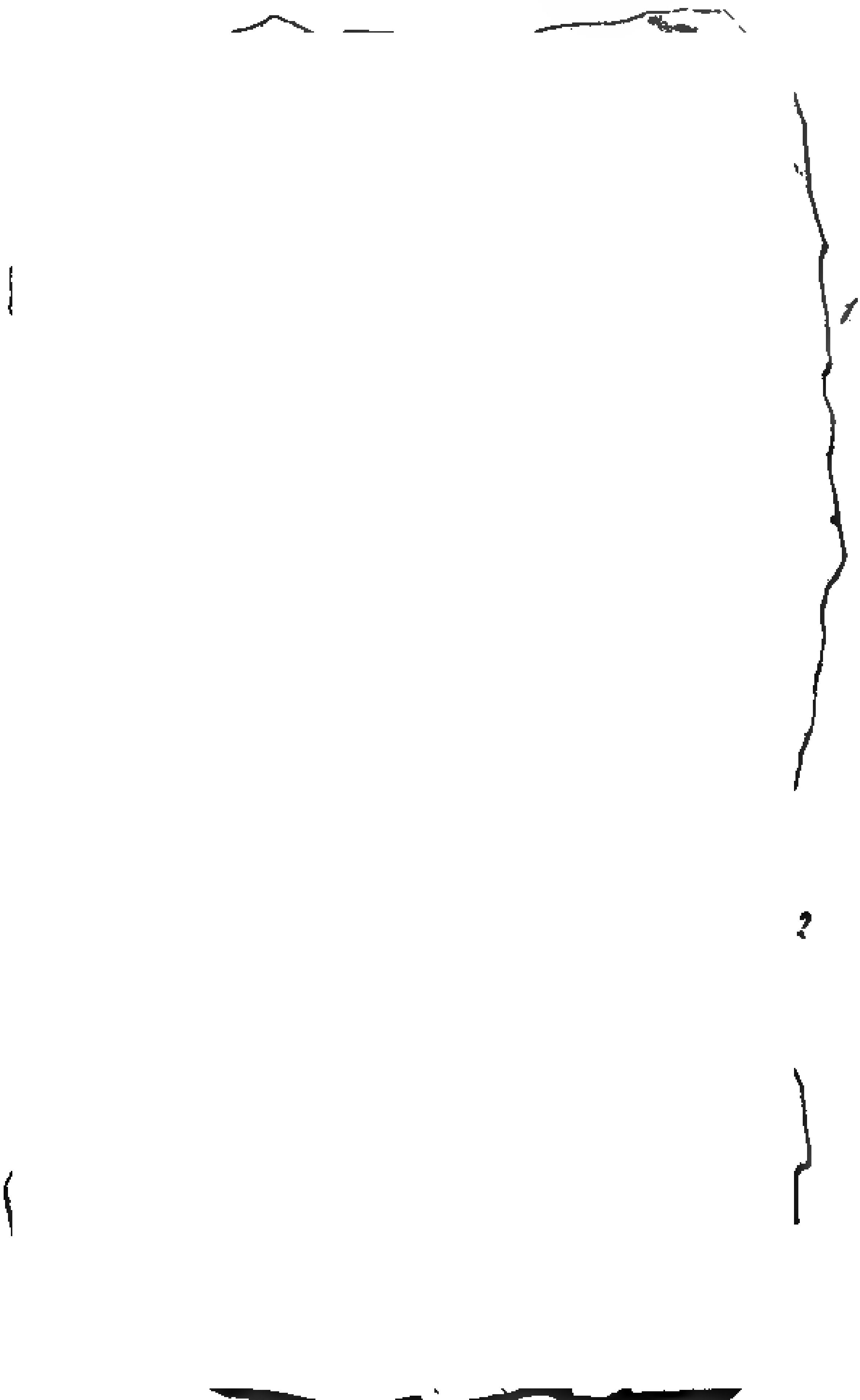
or the broadest part of the body, cut around and on the borders in short lobes by deep lines more or less corresponding with those above and below, and apparently coming like rays from the center, the upper disk being divided at the surface by these lines in equal rays, like a star. These layers or superposed disks are irregular in thickness, becoming thicker, and their borders less distinctly lobed at the widest part of the cone, where their measure is about five millimeters, reduced to three millimeters near the point. The top is flat, or rather, slightly convex, without trace of breakage. The lower or broader part is quite flat, marked around by a border three to five millimeters thick, as if the body had been funnel shaped, and its open mouth filled by sand. As in the former species, this organism seems to represent the enlarged base of a species of algæ, whose frond has been separated from the column; or, perhaps, as the upper disk does not show any trace of breakage, we have here the whole plant as it was, attached to the rocks or fixed to the sand by its enlarged adhering base, and growing up by a succession of superposed disks, diminishing in diameter. There is also a point of comparison for this peculiar vegetable in Hall, loc. cit., pl. x, figs. 9 and 10, and pl. vii, figs. 2 *a*, *b*, *c*, considered by the author as roots of *Buthotrephis*. They represent oval or globular bodies, regularly costate around a character which relates them to our plants. They are, however, very different, by their shape.

The specimen figured here is one of the smallest which have been found, and the only one communicated to me. It is three and one-half centimeters high, about four centimeters broad in its widest part, and one and one-half centimeters at the narrow end of the cone. I have seen, however, in the cabinet of the State Geological Survey of Illinois, at Springfield, some specimens evidently representing the same species, and which were at least four times as thick as this one. They had been discovered by Mr. I. H. Southwell, of Port Byron, Illinois, to whom I owe the communication of the one described above.

It may be suggested that this and the former species might, perhaps, be referable to sponges rather than to vegetables. This supposition can not be admitted for *Asterophycus*, on account of the tubercular rootlets which are growing from the lower face of the divisions, and marked, as they are, upon the specimens, by circular spots. There is also no trace of sponginess in the texture of their remains. If we are right in supposing that the broken part represents the axis of a frond, supported by a star-like rhizoma, we have indeed a relation, if not of forms and characters, at least of growth between *Asterophycus* and *Conostichus* species, and therefore have to consider these last, as vegetable organized marine bodies, like the former ones. Moreover, the form of *Conostichus ornatus* is too regular for sponges, and its substance, though transformed into a coarse sandstone, does not show any trace of pores or small cavities like those which are generally observable upon the fossil sponges.

Habitat. According to the statement of the discoverer, Mr. I. H. Southwell, in a sandstone bed of the coal measures, between coal No. 1 and No. 2, of the Illinois Geological Reports, or the stratum No. 5, in section p. 230, vol. 5, of the same report.

The description of these five species of marine plants opens a new chapter in the records of the vegetation of the Carboniferous age. The great developments of marine formations in the coal measures of the west where strata of limestone, some of them of great thickness, and intermixed with a profusion of marine animal remains, sometimes immediately overlie the beds of coal, has often suggested inquiries concerning the causes of the total absence of marine plants in the same strata. The scarcity of fucoidal remains in the wide expanse of the swamps where the coal had its origin, is easily accounted for, but not the total absence of these plants in the coal measures. Now, only, we are beginning to know something about the distribution and the nature of the marine vegetation during the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carboniferous period. It may be little as yet, but a reason the more valid for carefully recording the first discoveries in that new field of paleontology.

EXPLANATION OF THE PLATES.

PLATE I.

Figures 1 and 3. *Paleophycus Milleri.* Spec. nov. p. 136.

Figures 1^a and 1^b. Branch of the same, enlarged, showing dots on the surface.

Figures 4 and 5. *Paleophycus gracilis.* Spec. nov. p. 137.

Figures 4, 5^a, and 5^b. Fragments of branches of the same. Enlarged.

Figure 6. *Conostichus ornatus.* Spec. nov. p. 142.

PLATE II.

Figures 1 and 2. *Asterophycus Coxii.* Spec. nov. p. 139.

JENNINGS COUNTY.

PROF. E. T. COX,

State Geologist of Indiana:

DEAR SIR:—Agreeable with your letter of instructions, of April 21, 1875, I have closely traced the geological formations of Jennings and Ripley counties, Indiana; observed the character and position of pre-historic mounds; inquired into the agricultural and manufacturing interests, and herewith respectfully submit notes on the same.

Yours Truly,

WM. W. BORDEN.

New Providence, Ind., Jan. 1, 1876.

DESCRIPTION.

Jennings county was organized in 1816, and named in honor of Jonathan Jennings, the first Governor of the State of Indiana. It is bounded on the north by Bartholomew and Decatur counties, east by Ripley and Jefferson, south by Jefferson and Scott, and on the west mainly by Jackson and Bartholomew counties. The east and west sides of the county are nearly parallel, but the north and south borders are very irregular. This county contains 375 square miles, or 240,375 acres. Enumeration of children for school in 1874, 3,834. The surface of the county bordering all the streams, is very much broken, while rich

alluvial valleys and high table-lands or "flats," form the water-shed between the streams.

This county is traversed by a number of water-courses, those in the northeastern part, flowing near the summit of the Lower Silurian rocks, and those on the remaining portion, flowing over the Niagara and Devonian formations. All the streams in the western part of the county, flow from a lower to a higher geological horizon. The principal streams are: Big creek, which washes the county on the southwest, Big and Little Graham, uniting below San Jacinto, the latter rising east of New Marion, in Ripley county, and the former near Versailles, and the North or West Fork of the Muscatatuck, which unites with the South Fork at Old Vernon.

Sand creek, which rises in Decatur county, flows through the western part of this county, and, with its various branches—Rock creek, Nettle creek, Wyalusing, Bear creek, Rat Tail, and other small tributaries, is one of the main feeders of White river. Along Sand creek, as its name indicates, an abundance of good, brown sand is found.

There are yet other streams of some note, as Coffee creek, Six Mile creek, Tea creek, Ice creek, Storm creek and Wolf creek. The small streams and creeks are very crooked, but after their union carry considerable water and become powerfully erosive, cutting deep abrasions in the strata and forming grand and romantic scenery of great geological interest.

The most recent deposits of Jennings county occur in the following order;

Quaternary Beds.

		Ft.	In.
1. Alluvium, recent	2 to	20	00
2. Champlain 3. Glacial Drift	20 to	40	00

PALEOZOIC GEOLOGY.

The rock formations of this county, comprise three members of the Devonian age, and two of the Upper and one of the Lower Silurian. These rocks crop in various parts of

this county, and will hereafter be noticed in detail. They occur as follows;

DEVONIAN AGE.

Hamilton Group.

		Ft.	In.
4.	New Albany black shale, Genesee shale, N. Y.	45	00
5.	North Vernon dark blue, compact, stratified limestone, (equivalent of the hydraulic cement limestone of Clarke county, Indiana). A durable bridge and foundation stone, with an occasional upper ledge of gray limestone....	11	03½
6.	Corniferous limestone, containing the characteristic fossil corals, and at Scipio a white limestone, which, when burned, makes a very white lime	18	00

UPPER SILURIAN AGE.

Niagara Period.

		Ft.	In.
7.	Niagara gray stratified limestone; in most parts a good building stone, which makes, when burned, a good lime	40	00
8.	Clinton epoch	a trace.	

LOWER SILURIAN AGE.

Trenton Period.

		Ft.	In.
9.	Cincinnati epoch	32	00

Cincinnati Epoch.

A dark, compact, stratified limestone in the upper part, with some thin layers containing fossils, with unevenly bedded limestone and shale below, containing characteristic fossils.

The prevailing dip of all the strata in this county, is to the southwest, and the oldest one seen is represented by No. 9 of the Cincinnati epoch. These rocks, which crop in great force to the east of this, as in Ripley and Dearborn counties, have their most westerly outcrop on the south fork of the Muscatatuck, and on Otter creek and on the north fork of the Muscatatuck, as at Zenas, in the northeastern part of the county. The first show of No. 9 is seen at the Quaker mill, south fork, 2½ miles south of Butlerville, Campbell township. A section here, on Robert Whinery's land, creek bluff, shows as follows:

1.	Light colored clay soil with sand and an occasional boulder terminating in ocherous clay and sometimes a layer of sand above and again below 2 to 4 feet of hard pan	3 to 20 feet.
2.	A very hard siliceous stratified stone, a mass of corals and shells, corniferous, known here as "mill-stone grit," and used extensively by the early settlers for that purpose	3 to 5 feet.
3.	Brown magnesian limestone, (Dolomite)	8 to 12 feet.
4.	Light-gray shaly limestone, with white and gray compact flagstone below, (Niagara limestone)	30 to 45 feet.
5.	Dark-blue stratified limestone	5 to 6 feet.
6.	Brown magnesian limestone, shaly and clay layers below, showing on northside of creek	6 to 8 feet.
7.	Clay and shaly layers, blue, with Cincinnati fossils to the bed of the South Fork	2 to 3 feet.

Another section above, on the same stream, land of Harvey Wicks, Campbell township, shows a slight elevation of strata:

1.	Light colored clay soil, and deeper shades below, with chert	4 to 14 feet.
2.	Mill-stone grit	2 to 3 feet.
3.	Brown magnesian limestone, Dolomite	2 to 3 feet.
4.	Shaly limestone, with white and gray limestone below	2 to 3 feet.
5.	Blue stratified limestone	5 to 8 feet.
6.	Brown stone of the above section	5 to 8 feet.
7.	Clay and shaly layers, with blue limestone, Cincinnati	3 to 6 feet.

To the bed of the Muscatatuck.

The country here is broken along the streams, with rocky bluffs, and a scope of fertile bottom land opposite the high lands.

The following section is seen on the North Fork of Muscatatuck, below the mouth of Bush creek, and west of Butlerville, section 17, Campbell township.

1.	Light and ocherous colored clay with sand and boulders	5 to 15 feet.
2.	Millstone grit, full of fossils	3 to 4 feet.

3.	Dolomite limestone, very sandy, red color...	4 to 6 feet.
4.	Gray stratified Niagara limestone, in thick and thin flagging ledges, seen in out-crop along B. C. Heath's spring branch.........	30 to 45 feet.
5.	Dark blue stratified limestone.	
6.	Not found.	
7.	A trace of Cincinnati fossils in the bed of North Fork.	

There is no show of black shale in this part of the county A section, same as the above, occurs along Pleasant Run with the addition of a few feet more of magnesian and white limestone on the highest points. The No. 3, dolomite limestone of the above section, which is first noticed on Graham creek below Paris crossing in the southern part of the county, at the horizon of the corniferous limestone beds at Deputy, a short distance south, is in the northeast part of the county a sandstone of a reddish color. The Cincinnati out-crop thickens along the north fork, going towards the head waters of the stream, and showing fifteen to twenty-five feet of the Lower Silurian at Zenas, in Columbia township. Some two miles above Zenas, on the creek, I find the following:

1.	Ocherous clay soil, with sand and boulders..	15 feet.
2.	A very white stratified, crystaline limestone with a trace of pyrites and white chert below, and showing in all the bluffs, Niagara limestone..........................	5 to 8 feet.
3.	Thin stratified gray limestone, Niagara.....	10 to 20 feet.
4.	Blue and gray limestone, showing crinoid stems, with clay layers below, and characteristic Cincinnati fossils, shells and corals..	25 to 30 feet.

In the geological sections given above I have pointed out the position and extent of crop of strata which belong to the Cincinnati epoch, as seen in this county. The show of Lower Silurian is small and marks the boundary of that formation on the southwest but it increases in thickness to the east, as will appear in the geology of Ripley county.

The most southerly out-crop of Lower Silurian rocks in Indiana, as given in my survey of Clarke county, Geological Report, 1873, is on the Ohio river at the mouth of

Begg's run, one mile and a half above the mouth of Fourteen-mile creek. I shall have to correct that out-crop, for during the past fall, in company with H. C. Duvall and Phil. M. Dailey, of Charlestown, we traced that formation in a deep gorge which opens into Fourteen-mile creek, as far as Buffalo lick on J. Cole's branch and within one mile of Charlestown. Here the upper part of the Lower Silurian and Clinton show a remarkable amount of false bedding before the Niagara was deposited upon them. The Niagara strata are nearly horizontal or have a slight dip to the southwest after filling up the basin or trough of the underlying Clinton and Cincinnati. The false bedding is very marked where the branch has cut away the top of the cones which occur in a succession of four or five folds that are from two to three hundred yards apart.

UPPER SILURIAN AGE.

Niagara Period.

Clinton epoch, which is the next formation in the ascending order, has an outcrop only a few feet thick, overlying the Cincinnati. It contains a large per cent. of silica, lime and magnesia. In some localities, upon weathering, considerable beds of sand remain.

Niagara limestone: This formation is composed of gray and white, stratified, crystalline limestone, with occasional magnesian layers. These stones occur in heavy beds throughout the county, and crop along all the streams of any size. The most southerly crop of Niagara limestone in this State, is at the Falls of the Ohio, where it is sparingly seen at low water. It is 25 to 30 feet thick at Utica, on the Ohio river, and 75 to 80 feet on Fourteen-mile creek, in Clarke county. In Jefferson county, it thins out toward the Ohio river, where it overlaps the Lower Silurian. It passes through Jennings county, and is represented by a thin edge in the eastern part of Ripley county, and in the bordering counties, on the north and west of Jennings. The Niagara limestone has an extended crop along the eastern border of Jennings, as indicated above, and is easy

of access for quarrying building stone, curbing and flagging stones. These beds also furnish a good quality of quicklime.

The position of the Niagara rocks, in the southern part of Jennings county will appear from the following section above the mouth of Coffee creek, on or near Thomas Davis' land, section 36, Marion township:

1.	Ocherous clay soil, with sand..................	5 to 25 feet.
2.	New Albany black shale, here 5 feet.....in vicinity	40 feet.
3.	Stratified gray and blue limestone.........	10 to 13 feet.
4.	Stratified limestone, fine grained, light shade....................................	15 to 18 feet.
5.	Stratified limestone, (Niagara).	

To the bed of Big creek.

The land here is rolling, with shaly soil on the upland, and good, fertile, sandy bottoms on Coffee creek. A good outcrop of Niagara rocks, with some magnesian layers, is seen about the mouth of Graham, and on Neals creeks near Old Paris. The crop here is several feet in thickness, and many of the layers would make excellent lime and building material. Heavy beds of Niagara limestone show almost the entire length of Big Graham, even to its source in Ripley county; also along Little Graham from its junction with Big Graham at San Jacinto, to the head waters of the stream east of New Marion, Ripley county. An out-crop of the strata as seen on Big Graham, section 22, Bigger township, and on the land of Vardivan Hughes, shows:

1.	Ocherous clay soil.....................................	5 to 14 feet.
2.	A very siliceous, brittle strata, filled with fossil shells and corals—corniferous, called "Millstone Grit".........................	2 to 3 feet.
3.	Dolomite limestone, very bituminous, which contains disseminated masses, or nests of carbonate of lime, Iceland spar, showing double refraction, good cabinet specimens..............................	12 to 15 feet.
4.	Gray stratified Niagara limestone to the bed of Big Graham............................	12 to 16 feet.

A few sections of the outcroping rocks on the Musatatuck about Vernon will show the thickness of the Niagara formation near the central part of the county. One mile east of

Old Vernon, at the Tunnel mill owned by Wm. H. Sidell, section 10, Vernon township, the following crop occurs:

1.	Ocherous clay soil, with chert near the base	10 to	20 feet.
3.	New Albany black shale		10 feet.
3.	Blue stratified limestone (North Vernon)	2 to	4 feet.
4.	White limestone, stratified	8 to	10 feet.
5.	Flint ledge.		
6.	Dolomite limestone, brown color	6 to	8 feet.
7.	Gray stratified limestone, (Niagara)		20 feet.
8.	Blue shale in upper part, 4 feet, shaly, rough magnesian in lower part 4 to 6 feet.	6 to	12 feet.
9.	A fine-grained, stratified limestone, with chert	5 to	6 feet.
10.	A fine-grained, stratified limestone, capped with a better grade of building stone	5 to	8 feet.
11.	Various thicknesses of "flags," containing Othoceratites to the bed of Muscatatuck, (Niagara)		10 feet.

Less than two miles northeast of the Tunnel mill, on the Jeffersonville, Madison and Indianapolis railroad, at the well-known quarry of Christopher Harman, section 12, Vernon township, the following marked crop occurs on Carney's branch. With the assistance of Mr. C. Harman, I was enabled to make the following section:

1.	Clay soil	2 to	4 feet.
2.	New Albany black shale		5 feet.
3.	3 to 5 inches blue limestone, flagging (North Vernon)		5 inches.
4.	Hard, blue, stratified limestone, (North Vernon)		22 inches.
5.	Hard, blue, stratified limestone flagging with clay partings, (North Vernon)	8 to	12 inches.
6.	Hard, blue, stratified limestone, (North Vernon)		22 inches.
7.	Hard, blue, stratified limestone, (North Vernon)		16 inches.
8.	White, stratified limestone, flinty, corniferous		4 to 5 feet.
9.	White limestone in strata of 8, 16, 20 and 48 inches. It affords some good stone caps, sills, etc		8 to 9 feet.

10.	Rough limestone, double flint ledge.......	4 to 5 feet.
11.	Dolomite limestone, yellow, silicious in the upper part.	
12.	White clay shale	2 to 4 feet.
13.	Gray stratified limestone, blue in bank, makes good lime........	4 feet.
14.	Gray stratified limestone with cherty layers	3 to 5 feet.
15.	Deep blue, fine grained, compact limestone in strata of 16 to 22 inches..........	6 feet.
	To the bed of Carney's creek and to the south fork Muscatatuck	20 feet.

The above is a characteristic section of the out-crop of rocks at Vernon, where, on account of the deep gorges cut by many small streams and the short curves of the larger streams, various grades of stone are reached and easily quarried, in fact, nature has in ages past opened a series of quaries and laid bare the stone in this vicinity, from top to bottom of the Niagara series.

Following the South Fork into Campbell township, southeast of Butlerville, section 35, we have on Joseph Hole's branch.

1.	Light colored clay soil with yellow sand and a trace of black sand, also, ocherous clay and white and yellow chert..........	10 to 43 feet.
2.	Millstone grit, a mass of siliceous fossils...	3 to 5 feet.
3.	Dolomite limestone, bituminous and containing nests of carbonate of lime (Iceland spar), stone, weathers rough........	5 to 6 feet.
4.	Gray stratified limestone (Niagara), in layers of 12 to 18 inches, containing good building stone, and when burned makes good lime, and contains here crinoid stems, and specimens of fossil orthoceraties..	4 to 6 feet.
5.	Shaly and weathering limestone, projecting along the bluffs, containing orthoceras..	10 to 15 feet.
6.	Flagging limestone (Niagara), "Flat Rock"	10 feet.
7.	Brown and salmon colored magnesian limestone, Clinton..............................	6 feet.
8.	Magnesian limestone..................................	2 to 4 feet.
9.	Clay shale, containing (*Tetradium fibratum*) T. S...	2 to 3 feet.

10.	Very dark, compact stratified limestone, bituminous, in strata of 6, 12, and 18 inches, with some shaly layers, containing Zaphrentis corals	6 to 10 feet.
11.	Very dark, shaly, bituminous limestone the bed of South Fork.	

The above section is a fair representation of the crop in this region, as seen along numerous small streams and in deep gorges leading into the south fork from the east and west. The numerous exposed strata of Niagara limestone along the brakes afford an unlimited amount of excellent crystalline limestone for building purposes or for lime. Wood abounds here, and lime could be produced at small cost and the weathered, thin layers of stone will in time afford an abundance of material for building stone fences, when this, at present, well timbered region shall require it. Numerous small caverns occur in this strata, from which flow never-failing springs; also, sinks and large weathered vertical holes, some of which are very interesting on account of showing the weathering and decomposition of the rocks. In company with James Hole, Esq., I visited a noted locality of weathered cavities which some have imagined were made by pre-historic people. Three of these vertical holes, four to five feet in diameter, which penetrate the limestone strata to the depth of 25 to 30 feet, exhibit the appearance of having been excavated with a large auger.

On the west side of the South Fork, on the land of John C. Lee, north of Butlerville, section 24, Campbell township, the Niagara limestone out-crops in numerous places and presents a series of ledges suitable for building purposes. These crops are within one mile of the O. & M, railway, and afford fine sites for quarries. In Sand creek township, northwest of Campbell township, east side of Sand creek, section 11, on the land of William Kellar, the following out-crop occurs:

1.	Ocherous clay soil with sand and boulders.	3 to 15 feet.
2.	New Albany black shale in the summit of the hills........	12 feet.

3.	Blue stratified limestone, (N. V.) strata......	2 to 5 feet.
4.	Dolomite limestone, not seen.	
5.	Stratified gray limestone, Niagara, magnesian below	12 to 15 feet.

Another section on Sand creek, at Craig's bend, below the Tunnel mill of John S. Calhoun, shows:

1.	A light colored siliceous soil, with chert below	3 to 6 feet.
2.	Dolomite limestone.	
3.	Light colored stratified limestone in the crop, but gray within, in strata of 6 inches to 2 feet 2 inches......	4 to 6 feet.
4.	Gray shaly limestone with cherty layers, Niagara	12 to 16 feet.
5.	Flagging layers of limestone, 4 to 6 inches, "Flat Rock," to the bed of Sand creek..	20 in.

Dolomite limestone of the above sections out-crop on section 3, a short distance southwest of Brewersville, on the land of Daniel Bacon, and the indications are favorable that it is here a good building material; indeed, several layers of the above sections will afford durable building stone and good flagging; also, produce good lime if burned.

Having previously given some sections under the Lower Silurian division of the subject, showing the Niagara outcrop on the north fork of the Muscatatuck, in Columbia township, about Zenas, suffice it to say that the Niagara crop in that section on Wolf creek, Ice creek and other streams furnishes advantageous sites for opening good quarries.

DEVONIAN AGE.

Hamilton Group.

Corniferous limestone: Having traced this formation from the Falls of the Ohio river through Clarke, Scott and Jefferson counties, the layers have been found very uniform, and maintain the well marked characteristics of the stone, being rich in fossil corals of radiate and columnar forms: *Zaphrentis gigantea, Z. rafinesquii* and *Favosites goldfussi,* which always abound, the latter affording most excellent cabinet specimens, of large and small size, and in many

instances, bleached as white as snow, so that the delicate columns are distinct and beautiful. While the greater part of this species of coral is composed of very pure white lime, yet some specimens show a trace of iron, which gives them a beautiful shading. A coral bed appears at the quarry of Reynolds, Saulpaugh & Co., below Paris crossing, formerly the bluffs of Graham creek, and on the land of James McGannon.

1.	Ocherous clay soil..................................		20 feet.
2.	New Albany black shale..........................		4 feet.
3.	Blue stratified crystalline limestone, in strata of 2 ft., 2 ft. 6 in., to 3 ft. 1 in.		
4.	Other layers to "quick ledge"................		2 feet.
5.	Corniferous limestone containing, *Favosites goldfussi* and *Zaphrentis* corals.....	16 to	18 feet.

No. 5 of this section appears west of Paris crossing, at Solomon Deputy's, sec. 30, on Coffee creek; also on Slate branch, land of Calvin Hudson, where the following section is seen:

1.	Light colored clay soil, with sand..........	8 to	15 feet.
2.	New Albany black shale, with fossils in the lower layers..................................	30 to	45 feet.
3.	Grey stratified limestone, with fossil crinoid stems....................................	2 to	4 feet.
4.	Blue stratified limestone, (N. V. limestone)..	4 to	6 feet.
5.	Corniferous limestone, containing fossil corals, etc., to the bed of Coffee creek.		

The Corniferous limestone also contains a fine display of fossil corals on Neal's creek, adjoining old Paris, and along the bluffs of Graham creek; also, in some localities about Old Vernon, on the Muscatatuck. It will appear, from the sections given, that the "White limestone" and also the Dolomite limestone come in at various points in the place of Corniferous. This will be seen in the following section on Sand creek, land of James Moffitt:

1.	Ocherous clay soil..	2 to 12 feet.
2.	Black shale, (N. A.) found only on the highest points..	1 to 20 feet.
3.	Dark-blue stratified limestone, (N. V.) in the crop 6 to 14 inches..	3 to 6 feet.
4.	Brown, coarse grained limestone, containing *Spirifer acuminatus*, corals..	3 to 4 feet.
5.	Soft white limestone showing Corniferous fossils and crystals of pure carbonate of lime, and when burned produces a white lime..	10 to 15 feet.
6.	Magnesian limestone to the bed of Sand creek..	4 to 6 feet.

The stone comprised in No. 5 of the above section is highly prized in this and some other localities for its purity and the facility with which it may be burned into caustic lime. It has a good reputation and is known in the market as "Scipio white lime." No. 5 of the above section is not suitable in this locality for building purposes since it is liable to decay when exposed to the weather as may be seen in the piers of the J. M. & I. railroad bridge over Sand creek west of Scipio. It is not expedient or necessary that these layers should be used for exposed work, as the Vernon blue limestone crops on all the hill sides immediately above the white layers.

In Campbell township, the Corniferous limestone loses almost entirely its usual lithological character, as will be seen from the following section at Dudley Andrews', in this township, southeast of Butlerville, and on Campbell creek, a tributary of the South Fork.

1.	Clay soil with sand and chert..	?
2.	Siliceous fossil bed, "millstone grit," containing corals, fossil shells and an occasional trilobite and conocardium (Corniferous)..	3 to 5 feet.
3.	Brown, magnesian limestone, soft, weathering..	6 to 11 feet.
4.	Gray and light blue limestone, flagging and foundation stone, makes good lime, (Niagara)..	10 to 40 feet.
5.	Magnesian limestone to the bed of South Fork.	

No. 2 of the above section, as stated, is here very fossiliferous.

Immense quantites of large and small fossils are found on the hill sides and along the streams. The buhr stone is composed of small fossil corals and shells which give it a cellular structure, from which it derives the name of "millstone grit." In composition it is an impure flint or chert, and was used by the early settlers for constructing millstones. These siliceous layers do not appear at North Vernon, as will appear from the following section on Jordan's branch, commencing at Gallus Kuchner's quarry:

1.	Ocherous clay soil....................................	1 to 12 feet.
2.	Hard pan of blue clay and other shades....	6 feet.
3.	New Albany black shale, with two to three inches of yellow bog ore at the base.......	42 feet.
4.	Gray crystalline limestone, stratified with blue layers below, layers of 6, 10 and 18 inches, to 2 to 3 feet 3 inches................	6 feet.

The gray ledge of the above section contains a very great abundance of crinoid stems on the surface, with plates of *Cariocrinus ornatus* and other crinoidea; also, *Zaphrentis gigantea*, *Cyathophyllum rugosum*, *Favosites goldfussi*, and a massive branching coral not yet described, *Lucina proavia*, *Spirifer acuminatus*, a *Spiriferoides*, an *Athyrus* and *Dalmania peloine*, Hall, orignally described from the Falls of the Ohio. The blue ledges contain *Plathyceras dumosum* Con, a variety with distinct spines, some of the spines are three to four inches in length; also other fossil shells.

5.	Gray limestone, with chert "flint ledge"	5 feet.
6.	Soft white limestone, with chert in the upper 6 inches, contains fossil shells, splits well, strata 2 feet to 20 inches......	5 to 6 feet.
7.	White limestone striped with gray, "splitting ledge," splits in thin layers, makes good lime	4 to 5 feet.
8.	Blue and gray limestone..............................	6 to 8 feet.
9.	Dolomite limestone in strata of 2 to 6 feet with chert in some parts, and sand and clay layers	8 to 10 feet.
10.	Rough brown magnesian limestone to the bed of the Muscatatuck, above Vernon	6 to 12 feet.

Below Old Vernon, on the Muscatatuck, we have the following section on the land of Joseph Saddler:

1.	Clay soil	4 to 30 feet.
2.	Black shale	3 to 20 feet.
3.	Chert	5 to 6 inches.
4.	Gray and blue stratified limestone in thick and thin layers, with cherty concretions, flagging stone	4 feet.
5.	Gray stratified limestone, with crinoid stems on the surface	6 feet.
7.	White limestone, striped gray, splitting	5 feet.
8.	Various shades of limestone	8 feet.
9.	Dolomite, sandy, rough brown	10 to 12 feet.
10.	Dark brown, rough magnesian, with chert and calc spar	5 to 8 feet.

To the Muscatatuck creek.

The following secton was taken at the Huckleberry quarry beneath the bridge on the Vernon & Paris road.

1.	Clay soil	5 to 12 feet.
2.	New Albany black shale	2 to 8 feet.
3.	Blue limestone	4 to 6 feet.
4.	Flagging ledge	4 feet.
5.	White limestone	4 to 5 feet.
6.	Dolomite limestone.	
7.	Light blue shaly limestone, disintegrating in the lower part, in strata of 8 to 14 in.	5 to 6 feet.
8.	Light brown magnesian limestone	1 to 6 inches.
9.	Gray limestone, thick and thin layers, showing Orthoceratites, Niagara flags, to the bed of the Muscatatuck	5 to 8 feet.

The next deposit in the ascending series is the

NORTH VERNON LIMESTONE,

So designated from being first extensively quarried at that place, and shipped to various points by rail. This stone has acquired some reputation as the "North Vernon blue limestone." It lies at the horizon of the hydraulic limestone of Clarke county on the south, and is here a continuation of the same bed, but is a differently constituted rock. In Clarke county the entire beds, which are from 12 to 14 feet in thickness, are used for hydraulic cement, and known to

the trade as Louisville cement. The capping in the Vernon beds is in many places a gray crystalline limestone, resembling the cap stone of the cement. The strata of gray stone in many places overlying the blue, often contains a great number of crinoid stems; some plates of *Cariocrinus ornatus*, and some Corniferous corals.

The most valued layers are: a dark blue, compact, fine grained, stratified limestone, of good dimensions for bridge piers, flagging, foundation, and indeed for any work that requires durable material. The weight of this stone when dressed is from 180 to 185 lbs. per cubic foot. Since my survey of Jefferson county, an excellent quarry of this stone has been opened at Dupont, a locality refered to at that time as containing good stone. As the various layers are well exposed at this time, being freed from the debris which had covered the outcrop, I will repeat the section more in detail, for the quarry is here of great value. Some account of the railroad quarry was given in the last report (1874).

The quarry at Dupont is located on the land of Fernando Robertson and has been worked the past season by Henry Wrape & Co., of North Vernon. The arrangement of the strata is shown in the following section:

1.	Clay soil	2 to 3 feet.
2.	New Albany black shale	6 in. to 1 foot.
3.	Gray stratified limestone	3 feet.
4.	Dark gray stratified limestone.	2 feet.
5.	Three to four inches of iron ore	4 in.
6.	Fine, blue stratified limestone	14½ in.
7.	Dark blue ledge, flagging	7 in.
8.	Fine blue ledge, flagging	5 in.
9.	Shaly ledge, flagging	4 in.
10.	Blue ledge, containing white chert concretions	8 in.
11.	Blue ledge	13 in.
12.	Blue ledge	20 in.
13.	White limestone, corniferous	10 to 12 feet.
14.	Dolomite limestone	5 to 6 feet.
15.	Magnesian limestone to the bed of Lewis' creek.	

This quarry has been vigorously worked during the past season, employing 50 to 75 hands, cutting several thousand

yards of dimension stone, which have been shipped by rail from this quarry to Cincinnati, to be used in the piers of the Southern Railway bridge over Ohio river at that place. Large quantities of flagging and other grades of stone have also been shipped by rail to various points. The North Vernon blue limestone, as it is commonly designated, covers a considerable area in this county. It is seen in Jefferson on the south, and extends to Graham creek on the east, and is superimposed by the black shale, in the western part of the county, beyond Hardinsburg. It appears in the northwestern part of the county, at Scipio and Brewersville. The commercial value of the North Vernon limestone can not be truly estimated at present, as its reputation is increasing from year to year. It is most favorably located along the line of the Ohio & Mississippi railroad, and the Louisville branch of that road, also along the Jeffersonville, Madison and Indianapolis railroad. These roads lead to large and flourishing cities where the demand for stone is constantly increasing.

Herewith I submit the following communication from the well-known and experienced contractors, Reynolds, Saulpaugh & Co., now engaged in the construction of the piers of Southern Railway bridge over Ohio river at Cincinnati:

OFFICE OF REYNOLDS, SAULPAUGH & CO.,

CINCINNATI, O., Sept. 20, 1875.

PROF. WM. W. BORDEN,

Assistant Geo. Survey,

New Albany, Indiana:

SIR—Deeming it a matter of professional interest to yourself as well as others, we would respectfully call your attention, as a geologist, to the rock formation at and in the vicinity of Paris Crossing, Indiana.

During the present year we have opened and operated a

quarry on the farm of James McGannon, Esq., near the railroad station above named, and have taken therefrom, to present date, about 8000 cubic yards of dimension stone, which we are using in the construction of the substructure of the Cincinnati Southern Railway Company's Ohio river bridge, at Cincinnati, Ohio. The quarry we are working had never been tested prior to our commencing operations, but when stripped and developed, we found it consisted of the following strata:

The first, or top strata being 2 feet thick.

The second strata being 3 feet thick.

The third strata being 26 to 28 feet thick.

Each stratum being very uniform in thickness, horizontal in position, good even beds, without intervening layers of earth or other material, and all of blue limestone.

There is also a fourth strata underneath these, of blue limestone, two feet thick, of the kind known among quarrymen as "quick ledge."

We have had large experience in masonry and stone work, especially in the construction of bridge masonry, and we are free to say that this quarry, and those of the vicinity adjoining, are among the very best limestone quarries we have seen west of the Alleghanies, not only for ease and facility in operating, but for firmness of texture and durability of material. Indeed, we hazard nothing in saying that, in our judgment, the three strata first mentioned, for ordinary purposes of foundations for buildings and bridges, under all ordinary circumstances, are equal to Missouri granite.

We should be pleased to have you visit and examine these quarries, at your earliest convenient opportunity, deeming them well worthy your official attention.

We have the honor to be,

Respectfully Yours,

REYNOLDS, SAULPAUGH & Co.

The above firm have employed during the past season from three to four hundred hands, and quarried and cut

some eight thousand yards of stone. This stone is worth on an average when dressed, nine dollars per yard at the quarry, fourteen to fifteen dollars at the bridge, and twenty-two dollars in the piers.

The Kerchner quarry at North Vernon was also worked during the past season by John Droitcour; employs fifty to seventy-five hands in preparing stone for the bridge mentioned above. A section at the Kerchner quarry where worked, gives:

1. Ocherous clay soil mixed with black shale	2 ft. 00 in. to 4 ft. 00 in.
2. New Albany black shale	4 ft. 00 in. to 6 ft. 00 in.
3. Dark blue limestone with crinoid stems and shells	2 ft. 06 in. to 3 ft. 03 in.
4. Dark gray stratified limestone "flagging ledge"	10 in.
5. Dark blue stratified limestone	1 ft. 10 in.
6. Dark blue stratified limestone, with fucoid impressions on the surface	1 ft. 2 in.
7. Cherty ledge, ("nigger heads")	5 feet 00 in.

Some sections taken in the Kerchner quarry at the close of the work this season, show as follows. The dip of the ledges in the quarries is 1½ to 1¾ inches to the southwest, in 100 feet:

1. Clay soil, yellow	4 ft. 00 in. to 5 ft. 00 in.
2. Black shale, New Albany, with fossils, *Leiorhynchus quadracostata*, *Chonetes lepida*, *Tentaculites fissurella*, and *Lingula spatulata*, also nodules of iron pyrites	4 ft. 00 in. to 6 ft. 6 in.
3. Dark blue stratified limestone, and partings in places having imbedded on the stone crinoid stems of great length and roots or bases, upper part of the ledge 10 inches total	2 ft. 03 in. to 2 ft. 06 in.
4. Deep blue stratified limestone containing nests of white chert adhering to ledge below, which is	1 ft. 11 in.

On the north side of the hill at the same quarry we find:

1.	Light colored clay with ochreous shades below	2 ft. 00 in. to 4 ft. 00 in.
2.	Black shale with ochre below, thin strata, 2 in	3 ft. 00 in. to 4 ft. 00 in.
3.	Gray stratified limestone, containing an abundance of *crinoid* stems, and plates of *Cariocrinus ornatus*, *Zaphrentis* and an undescribed species of branching coral; also fossil *Anchorochrinus*	2 ft. 09 in.
4.	Partings of clay	0 ft. 02 in. to 0 ft. 03 in.
5.	Dark blue stratified limestone, containing nests of white chert, shows on the edge	0 ft. 08 in. to 0 ft. 10 in.
6.	Dark blue stratified limestone with a very good upper face	1 ft. 08 in.
	Fifty feet west of the above section, in the same outcrop, the gray limestone is absent.	
	Clay, black shale and ochre as above, with No. 3 gray limestone	6 in. wedge shape to 0
4.	Partings of clay.	
5.	Dark blue stratified linestone, taking the place of the gray of No. 3, same horizon	2 ft. 02 in. to 2 ft. 09 in.
6.	Flagging ledge containing chert	0 ft. 09 in. to 0 ft. 10 in.

The overlapping of strata of different grades of rock show a washing of material from different localities and in different directions. Messrs. Hicks and Holmes, in Geneva township, section 20, on the J., M. and I. railroad, west of North Vernon, employ 15 to 25 men in quarrying and cutting stone for various purposes. This quarry has the following outcrop:

1.	Clay soil	3ft. 00 in. to 4 ft. 00 in.
2.	N. Albany black shale, with 3 in. of bog iron at the base	3 ft. 00 in.
3.	Gray stratified limestone with fossils	2 ft. 04 in. to 2 ft. 09 in.
4.	Dark blue stratified limestone with fossils	15 in.
5.	Blue limestone, two ledges, (quarry worked)	1 ft. 6 in. and 1 ft. 7 in.

6.	Blue flagging, curbing, etc., 3 ledges, (quarry worked).......	each 7 in.
7.	Blue limestone, four ledges, (quarry worked)......................	each 10 in.
8.	Blue limestone, thin ledges, (quarry worked)......................	each 9 in.
9.	White limestone........................	
10.	White limestone, with chert, etc..	

A large quantity of stone is cut into sills, caps, steps, water-tables, ranges, etc., and shipped to various points. The Vernon blue limestone shows to the west of this, and outcrops about Queensville, as shown by the following secsection, taken to the east and west of that place.

Section on the Madison & Indianapolis State road, Geneva township, section 18, land of J. B. Smith, County Commissioner:

1.	Soil, clay with chert..	6 to 8 feet.
2.	New Albany black shale..................................	6 to 8 feet.
3.	Vernon blue limestone, upper as seen.....	1 ft. 4 in.
	Other strata, total	4 to 5 feet.
5.	Grey shaly limestone....................................	6 to 8 feet.
6.	Pure white stratified limestone; the upper layers weather well where seen in a culvert on the J. M. & I. railroad; the lower part shaly; in all..............................	10 to 15 feet.
	To branch.	

A section west of Queensville, on the J. M. & I. railroad, section 13, Geneva township, land of G. P. Campbell:

1.	Light-colored clay soil with yellow chert below, and sand and an occasional bowlder..	6 to 20 feet.
2.	Two to three hard strata, with fossils....	2 ft. 6 in.
3.	Black shale	
4.	Blue stratified limestone, first ledge.......	1 ft. 2. in.
	Second ledge..	6 in.
	Third ledge...	1 ft. 10 in.

This valuable limestone still continues to the west, and crops about Scipio. A good outcrop, not much worked, is seen on Thomas Wilkerson's land near the village. This

stone also crops along Rock creek at Samuel Marshe's, in Geneva township, section 29. The strata exposed are:

1.	Ochreous siliceous clay soil and boulders...	4 to 20 feet.
2.	New Albany black shale........................	0 to 8 feet.
3.	Gray stratified limestone.....................	2 to 4 feet.
4.	North Vernon blue limestone..................	3 to 4 feet.
5.	White limestone, splits well and makes good lime..	6 to 10 feet.

The dip of the rocks on this stream, as on all the streams in this county, is to the southwest. To the west of this the blue limestone is covered by a thick bed of black shale. South of this, in Spencer township, this stone crops, and may be traced in the bed of Six-mile creek from the most southern exposure on the land of A. L. Swarthout, at Hardinburg, for some three or four miles, but rising in the direction of Queensville, where it is found on the summit of the hills. The blue limestone is in thick strata and quite even bedded at Hardinburg, but lies lower down in the valleys. The following section was taken at the railroad quarry, crossing of the Hardinburg and Paris road on Six-mile creek:

1.	Light yellow clay soil with sand and boulders...	2 to 15 feet.
2.	New Albany black shale, containing fossils and pyrites..................................	4 to 15 feet.
3.	Thin ledge of coarse-grained limestone, composed of crinoid stems and fossil shells...	2 to 4 in.
4.	Vernon blue limestone, 2 to 4 strata exposed to the bed of the creek, the surface of the stone shows an abundance of fucoid markings...	4 ft.

South of Hardinburg along Six-mile creek, and also to the west of that place, the blue limestone is again encumbered with the black shale. These limestone beds are continuous from Hardinburg to Paris crossing, and in many places lie under heavy beds of black shale and soil. The great demand during this season for compact and durable limestone for bridge work and other purposes has given a fresh impetus to the quarry business in this section, and many new quarries are being opened. John Droitcour, of North Vernon, has

recently opened a quarry on the land of W. H. Lawrence, a short distance east of Commiskey Station, on the Louisville branch of the O. & M. railroad. The crop shows:

1.	Clay soil..............................	1 ft. 00 in. to 2 ft. 06 in.
2.	Blue limestone flagging............	06 in.
3.	Blue limestone........................	08 in.
4.	Blue limestone beds.................	2 ft. 00 in. to 2 ft. 06 in.
5.	Blue limestone, 3 to 4 layers of 5 to 10 in..............................	20 in.
6.	Blue limestone........................	2 ft.
7.	Blue limestone........................	14 to 15 in.

This quarry has been leased by Mr. Droitcour for a term of years. In this part of Montgomery township, bordering on Graham creek, the blue limestone is easy of access. A fine exposure is seen on the bluffs above Jesse Tate's cave, section 28, and at several other places on his land; also, on the land about Lowery cave, section 21; also, on the land of J. B. Johnson, west of Commiskey, section 20, and within a half mile of the railroad; others again one mile north on the railroad at Sherman, and on the land of W. H. Conner, northeast quarter section 17. A section on Conner's branch, which rises a short distance above the railroad, contains:

1.	Ochreous clay, with white chert below.......	2 to 10 feet.
2.	New Albany black shale..........................	5 to 10 feet.
3.	North Vernon blue limestone not worked which shows 3 and 4 strata.....................	6 to 18 in.

This stone crops on Coffee creek, a short distance to the west. Following the line of the O. & M. railway to Lovett, section 33, land of John S. Thomas, bordering on Graham creek, the country becomes broken, and on section 3, township 5, range 8 east, Lovett township, the blue limestone out-crops at several localities. The various quarries of this stone throughout the county will be able to supply any demand that may be likely to occur. Near Old Vernon is Fowler's quarry, widow Reid's quarry, and east of Vernon on the J. M. & I. railroad is the quarry previously mentioned of Chris. Harman, the quarry of Aulghe & Durth, the McMannus quarry, worked by James Vansickle. To mention all the quarries would be to give the out-crop on every

branch or hill-side. Adjacent to North Vernon, on the land of T. O. Johnson, the blue limestone crops, and from indications good quarries may be opened on his land.

Next in order in the Hamilton group is the

NEW ALBANY BLACK SHALE—EQUIVALENT OF THE GENESSEE SHALE, N. Y.

These beds are continuous from the base of the knobs below New Albany to the north through Floyd, Clarke, Scott and Jennings counties, excepting where the beds have been cut through by weathering and by streams, thus showing the shale beds to have been continuous at a former period. The heaviest deposits of black shale are in the western part of the above counties where the beds are superimposed by the knob range, or the table lands which occupy the horizon of the knobs, with the thin edges or eastern border resting on the Devonian and Niagara rocks.

The black shale appears in nearly all the sections given above. It is the surface rock in this county and always maintains the same stratigraphical position.

The black shale in Jennings county, is in the main, as in the counties to the south, of a thin, laminated structure, and crumbles upon exposure; yet, in some localities it can be quarried in thick, compact slabs, and is used for walling wells, and has been utilized in steam boiler furnaces, withstanding great heat after the volatile combustible matter has been burned out. Black shale, as the name indicates, is generally of a very dark color when first exposed, and in many places very bituminous. When saturated with moisture it resembles cannel coal; in some localities it has an ocherous shade, probably due to the oxidation of the pyrites which it contains. The dark-coloring matter of the shale is of vegetable origin, and is found to contain ten or twelve per cent. of oil. The carbonaceous matter renders it of considerable heating power, but, up to the present time, it has not been much utilized as a fuel. It is perhaps worthy of note, that in New York the spontaneous flow of carbureted hydrogen gas, from a similar shale, has been

extensively employed for lighting buildings. When burning, this shale evolves a heavy smoke having the smell of burning coal, but unlike the latter, it suffers no perceptible diminution of bulk, the residue being a stone of light appearance with a base of silica and alumina. This residue, if ground and incorporated with fire clay, would probably make a good fire brick. The bituminous nature of the black shale has led many persons to suppose that the out-crop of shale banks are an indication of coal. The occurrence of seams of one to two inches of pure bituminous coal in the shale, in some sections, has had a tendency to strengthen this belief. In some places it contains masses or concretions of very hard, impure limestone. These concretions are often spherical and from a few inches to three to four feet in diameter.

Heavy beds of shale occur along Coffee creek at its junction with Big creek, and to the west to the line of Jackson county, cropping to the east and west of Coffee creek in thick beds, as on the land of Solomon Deputy, section 30, Montgomery township, where the crop is from thirty to forty feet, showing thin seams of coal, also thin layers, and nodules of pyrites. Some layers of blue as well as black shale occur in this locality. The water flowing over or from the black shale deposits gelatinous oxide of iron; well-water from the shale has generally an astringent inky taste. As before stated, the shale beds are very continuous in the western tier of townships in this county—Marion, Spencer and Geneva. In Spencer township it covers the blue limestone from the Muscatatuck on the south and west to Hardinburg. At the latter place, in the bed of Six Mile creek, the base of the shale is again seen with a crop of blue limestone. The fossils usual to the shale are found in this locality; also crinoid stems penetrating it from a stratum of limestone below. These masses of stems give evidence of an abundance of crinoidea in the limestone series of the Hamilton Group. The imprint of fossil plants, calamites, are frequently seen, and fossil wood of conifera. Mr. J. Swarthout, of Hardinburg, has a good

pecimen of this wood in his possession. From the large amount of pyrites found in the shale on a small stream in this region, it has received the name of Silver creek. To the north of this, in Geneva township, heavy shale beds occur, as around Scipio, and to the west and east on Sand creek, in Center, Vernon and some in Bigger township. At the North Vernon quarries, an abundance of *Tentaculites fissurella* appear imbedded in the shale near the lower part of the series. Good specimens of black shale fossils are to be found on T. O. Johnson's land, a short distance northwest of North Vernon at the juncture of the blue limestone with the black shale. The fossils occurring here are *Leiorhynchus quadricostatus*, *Chonetes lepida*, *Tentaculites fissurella*, and *Lingula spatulata*.

QUATERNARY BEDS.

The Quaternary rests immediately upon the Paleozoic rocks noticed in the preceding pages.

The influence which this period had upon the general appearance of the country is very marked. In this part of the State, where the strata are conformable, glaciation worked great changes by cutting away strata and gave rise to a variety of enjoyable scenery. It is true that the streams, by their erosive force, have lent their aid in cutting down the rock formations to a greater or less depth, and in producing valleys and bluffs which give an undulating appearance to the surface of the deep beds of clay, sand and gravel. It has been found, on what is here called "Flats," that in sinking wells to the depth of forty to fifty feet no stone is met, yet, perhaps, a short distance on either side, heavy ledges of limestone are struck in shallow wells.

It is the generally accepted opinion that the drift came from the north, and is made up of white, yellow, black and various shades of colored sand derived from the coarser gravel and boulders. The greater part of the drift is made up of mineral matter foreign to the rocks of this State. Small particles of very pure gold are frequently found in the sands. Boulders of stratified rocks are sometimes

found, while granite boulders of various sizes are met with throughout the county, in many places quite large and abundant.

Boulders are rarely seen upon the "flats," but upon the inclined slopes where the clays have been washed down; thus, large boulders are more frequently seen on the borders of large streams. They occur quite frequently on the region bordering the South Fork of the Muscatatuck, and especially on the land of Joseph Hole, in Campbell township, section 35. The largest boulder seen in the county is found here, and measures eight feet in length and five feet in width and thickness. It is a very dark and hard granite.

The drift throughout the county affords an abundance of sand which is washed down into the streams. Sand is especially abundant, and some boulders in the northwestern part on Sand creek.

CHAMPLAIN PERIOD.

This comprises the ancient stratified siliceous clays, which are generally of light and dark yellow shades below, and terminating in a blue clay. The blue glacial clay is often found to contain imbedded trunks, limbs, roots and leaves of trees. This is a very marked feature of the clays about Paris Crossing. Timber has been exhumed from several wells at Paris Crossing that are situated on lands elevated some sixty to seventy feet above the bed of Graham creek. I examined the material taken from a well recently sunk here by Mr. John F. Files, in which the following deposits were passed through:

1. Light colored clay, with deeper shades below	10 feet.
2. Ochre colored clay with flint pebbles, increasing in hardness towards the bottom	19 feet.
3. Very hard bed clay and gravel	2 to 3 feet.
4. Blue drift clay, very sandy, with water; also, limbs, twigs and roots of trees, continuing to the depth of	7 to 10 feet.

Here the ingress of the water prevented the deepening of the well, and the wall was commenced upon the driftwood.

After the first round of stone curbing was placed down, a limb six inches in diameter was taken from the center of the well. At the time of my visit they were using this wood for fuel, and Mr. Files stated that he supposed he had taken as much as a half cord of wood from the well. Specimens of this wood, which has the appearance of being birch, have been forwarded to the State collection. It is of a dark color but not carbonized, and in many parts very much crushed and twisted, showing that it had been subjected to very great force. The clay lands of the "flats," which form the water sheds between all the streams, are of the Champlain period, and contain vegetable material which was borne down from the higher lands and deposited far above the flood tides of the streams of the present age.

The compact, tenacious character of the clay soil of this region is not remunerative under the old mode of growing crops, but it may be rendered so by liberal underdraining.

There are deposits of blue clay in the lower parts of these beds, often but two or three feet from the surface, well suited to the manufacture of tiles. Frequently irregular layers of yellow sand are found in the Champlain clays, sometimes these over-lapping one another, and again they appear horizontal.

ALLUVIAL, OR RECENT.

This deposit is seen along all the streams, and composes the low lands or river flats. It is derived from the weathering or disintegration of the rocks, from the washing down of the glacial drift, the undermining of terrace deposits of sand and gravel, and the dark vegetal mold washed down from the hill-sides.

The most productive lands in the county, are those situated in the creek bottoms and along the base of limestone crops. On the limestone slopes, bluegrass finds a congenial soil; one that is rich in all substances that tend to promote its vigorous growth. In the bottoms the soil is generally porous clay loam or sandy loam, which affords natural drainage for superabundant water, and renders it easy to

cultivate, warm and productive. The up-lands are largely derived from the decomposition of the black shale. The soil is mostly clay, and rather difficult to cultivate profitably, without first being drained.

North of Scipio, bordering on Wyalusing and Rat Tail creeks, the land is very broken. Bordering on Sand creek, section 1, Geneva township, at Thomas Wilkerson's it is more gently undulating.

ANTIQUITIES.

Pre-historic stone implements are found throughout the county, such as stone axes, flint arrow-points, spear heads, knives, fleshers, and various stone ornaments, evidently the work of a pre-historic race. These relics are most frequently met with along the larger streams, or on some elevation at the confluence of water courses. The intelligence of this race is farther shown by remains of extensive structures of earth and stone, evincing design and some skill in labor. The remains of the largest work of the mound-builders in this county is to be seen on the bluffs elevated 75 to 100 feet above the bed of the creek on the land of John E. Calhoun at a short bend in Sand creek, and a short distance from Brewersville, in Sand Creek township. It is a stone mound 71 feet in diameter, showing at this time, a hight of 3 to 5 feet above the surrounding surface. The exterior walls appear to be made of stones placed on edge, but the central portion did not show any regular arrangement of the stones.

I was informed by Daniel Bacon, who resides in Brewersville and saw this mound thirty years ago, that it was at that time twelve to fifteen feet in hight, and that upon opening it bones and charcoal were found beneath a flat stone near the centre. Large quantities of stone have been hauled from it and there is upon the ground a spring-house or out door cellar constructed of stone taken from it. It also furnished the stone for the underpinning of two or more houses. The rock in this mound, is principally from the bluffs below, with an occasional boulder. A

neck of land 25 to 30 feet in width intervenes between the rock mound and what is supposed to be a natural mound situated on the bluff some three hundred yards distant. The summit of this mound is fifty to seventy-five feet above the creek bed. There are indications of two stone walls across the neck about fifty feet apart. A road passes along the narrow neck which unites the peninsula of five to six acres with the mainland. A rich alluvial bottom lies to the southwest of the creek. Numerous blocks of stone, five or six feet in hight, which have fallen from the bluff above, lie scattered along the neck and are weathered into fanciful forms.

Other mounds occur west of Butlerville on the North Fork of Muscatatuck creek. A number of pre-historic implements have been donated to the State Cabinet by various liberal persons in the county, all of which have been forwarded with the donor's name.

AGRICULTURE.

The agricultural interests of the county are conducted by the County Agricultural Society, which owns nicely located grounds near North Vernon. The following are the present officers: John W. Coryea, President; Jas. B. Smith, Vice-President; Geo. W. Swarthout, Secretary; Joseph Hole, Treasurer; Charles Brenner, Marshal. The Patrons of Husbandry have a number of working granges throughout the county. This county does not contain any very large tract of fertile lands, yet the lands average in fertility with those of many other counties in the State. The " Flats," when properly cared for by drainage, will in time become the most valuable lands in the county. these lands are not subject to denudation by washing, and whatever fertilizers they may receive as plant food, will afford a generous return. The good effect of adding fertilizers has been noticed for a number of years.

The " Flats" are in the main composed of cold, tenacious clay soil, and without drainage are rather unremunerative,

except for meadow land; yet by reason of the drouth of 1874, they yielded good corn crops. The past season was too wet, rain continuing almost unabated for forty-two days.

As a general rule, the rolling lands bordering the numerous streams are more productive than the "Flats." Bordering on Sand creek, North and South Fork of the Muscatatuck, and Big and Little Graham, are rich alluvial bottoms yielding bounteous corn crops. In fact, all the small streams of Coffee creek have more or less of such lands along their border.

The principal productions are corn, wheat, oats, rye, buck-wheat and hay. The wheat, oats and hay crop was almost an entire failure this season, on account of the continuous rains at harvest time.

A considerable area is in pasture, and large numbers of mules, horses and cattle are raised for the Cincinnati and other markets. Large numbers of hogs are also fattened for various markets. The disease known as hog cholera is quite prevalent this season, and the most practical farmers attribute the disease to parasites, which find lodgment in the intestines of the hog, and finally develop themselves into worms, which destroys its health and terminates in death. Wood ashes, salt and sulphur are considered good preventives.

MILK TRADE.

Milk was first shipped by rail to Louisville from Clarke county in 1873. During the present year (1875), Elisha Carr has shipped from that place over $3,000.00 worth of milk. Paris, in this county, is also beginning to ship considerable milk.

FRUIT.

The usual varieties of summer and winter apples do well; occasionally, cherries and pears. Peaches are not extensively grown. Wild blackberries are quite a source of income at some points, also wild grapes. Strawberries are successfully grown about Butlerville.

TIMBER.

Jennings county was formerly covered with a very heavy growth of timber. The timbered lands of this county may be classed under two heads; first the "flats," which were originally covered with large and tall timber: white oak, beech, gum, soft maple, burr oak, hickory, and some other varieties, with a thick undergrowth in many sections, interwoven with native grape vines. The undergrowth is the thickest on the wet "flats," where the beech was almost entirely killed by the heavy frost of May 8, 1833. In some sections, the tops of the white oak timber was killed. The frost of that spring was late and severe, killing all the fruit in this section of the State, except a few late varieties of apples. Second, the rolling land, where the timber is white oak, black oak, beech, sugar, linden, ash, black walnut, white walnut, cherry, poplar, with an undergrowth on rich bottoms of pawpaw, and an occasional large sassafras. On the land of Joseph Hole, Esq., bordering the South Fork, are two sassafras trees, the first measuring four feet in diameter four feet from the ground, the other somewhat less. These trees stood near each other. The first tree was cut for saw stocks and shingles; the top of the last cut, forty feet from the stump, measured three feet in diameter. On the bottom lands along the streams, sycamore, hackberry, elm and buckeye flourish. These forests have, as a general thing, been stripped of the best timber. The white oak has been extensively cut for staves, the upper parts of the trees being left to decay upon the ground. In some sections the native forests remain almost untouched, and from these we can form some conception of their vigorous growth.

There are a number of saw and grist mills throughout the county, which will be mentioned with the towns in which they are located.

MINERALS.

The principal minerals of value in this county are, building stone, limestone for lime, brick and tile clay. The continuous beds of North Vernon blue limestone are

very valuable and extend over a large area of the county, as already stated. The amount of this stone quarried this season for the Cincinnati Southern railroad bridge, over the Ohio river, besides a great many other shipments which are constantly being made from the various quarries, has given employment to a large number of hands within the county. The layers of blue limestone will, alone, in the course of time, bring an immense revenue, while immediately below are the white limestone layers which afford good material for white quick-lime. Quick-lime is now manufactured at Scipio by Daniel Miller, and by Christopher Harman east of Old Vernon on the J. M. & I. railroad, and at other points. Below the white limestone are the Niagara rocks, which are noted for making good lime, and for building and flagging purposes. Good ocherous clay, suitable for red brick is found convenient to all the large towns. Good bricks are burned at Old Vernon, also at North Vernon. Sand for all ordinary purposes is to be found along all the streams throughout the county.

GOLD.

Some particles of gold have been panned from the bed of the south fork of the Muscatatuck. This gold ("color") was found in combination with the black sand washed down from the glacial drift of the uplands. The excitement occasioned by this discovery was very great at the time, and some useless labor was spent in sinking a shaft, as the drift and accompanying gold dust was foreign to the State. It was useless to penetrate limestone strata below in search of it. A small per cent. of gold is mingled with the "drift" throughout the State.

MANUFACTURES AND IMPORTANT TOWNS.

Vernon, the county seat, has a very romantic situation on the bluffs of the Muscatatuck, at the junction of the North and South Forks. It is a town of 500 to 600 inhabitants, and has railroad communication by the J., M. & I. railroad. The court house is a very nice brick structure,

ornamented with white limestone from the surrounding quarries. It was designed by Isaac Hodgson, Esq., of Indianapolis.

The leading industries of the place are: R. Lovett, spokes and hubs; J. H. Wagner & Co., foundry and plow shop; S. Vawter, stave and heading factory; Doll, Reynolds & Co., woolen and flour mill; Cotton & Reade, wagons, buggies, pumps and rakes; M. Butler, plow manufactory. *Vernon Banner*, C. E. Wagner, editor and publisher. One mile east of Vernon is the Tunnel mill, owned by Wm. H. Sidell and Robert Manville. This mill is engaged in the manufacture of various grades of wrapping paper from straw and rags. The brand is the Tunnel Paper Mill, Manville & Sidell, Vernon, Ind. Wheat and corn are ground at this mill. The building is a three and a half story stone structure; the power is obtained by water from the creek above, brought through a tunnel 300 feet in length and 20 feet fall.

North Vernon is situated at the junction of the Ohio and Mississippi railroad, the Louisville branch, and the crossing of the Madison branch of the J. M. & I. railroad, and is a city of 2,500 inhabitants. The manufacturing interests are: Tripton Flour Mill, by Eldro Hicks; H. Meyers, furniture and planing mill; Tripp, Jones & Brougher, woolen mill; Fred. Evans & Co., chair and furniture factory; Thomas C. Jones, chairs; Barnard Haily, wagons; Whitesell & Bro., wagons; also, harness shops and cigar factories.

The various religious denominations are represented by the Methodists, Presbyterians, Catholics and Baptists. Good schools are also located here.

Scipio is situated on the J., M. & I. railroad. Here the Scipio white lime is burned by Daniel Miller.

Queensville is located on the same road between this and North Vernon.

Paris is an old town, situated on the bluffs of Graham creek.

Paris Crossing is on the O. & M. railroad, and has a merchant mill owned by Harvey Hartwell.

Commiskey, Sherman and Lovett are located on the O. & M. railroad, south of North Vernon.

Butlerville and Nebraska on the east. Two large saw and lath mills cut a large amount of building material at Butlerville, owned by Thomas Bewley. Woolf & Neale have a mill at Nebraska.

Zenas is situated on the North Fork, Columbia township.

Brewersville, on Sand creek, has a saw mill owned by John E. Calhoun.

Hardinburg, on the O. & M. railroad, has a merchant mill.

OIL AND GAS WELLS.

During the coal oil excitement some years ago, a bore was sunk at North Vernon to the depth of 915 feet without finding oil. Two other bores were sunk at the Tunnel Mill east of Old Vernon. In the first at the depth of about 100 feet, gas was struck which ignited and burned 12 hours, when it was extinguished. This bore was abandoned and another sunk near by to the depth of over 900 feet without any beneficial result.

CONCLUSION.

In conclusion, I desire to return my thanks to the citizens of Jennings county for courtesy and favors. Space will admit of naming but few: P. C. McGannon, Auditor of Jennings county; Joseph B. Smith, Queensville, Edward Marsh, Six-Miles, Charles J. Corgell, Vernon, County Commissioners; T. O. Johnson, John N. Marsh (Editor *Sun*), Col. H. Tripp, W. C. Norris (Editor *Plaindealer*), T. J. Snodgrass, Gallus Kerchner, North Vernon; B. F. Russell, M. D., Solomon Deputy, W. Davis, Paris; W. H. Conner, Sherman; E. P. Nellis, J. M. Lyle, M. D., Commiskey; John S. Thomas, Lovett; H. C. Bruner, J. P. Swarthout, Hardinburg; E. L. Parker, Queensville; Thos. Wilkerson, James H. Wilkerson, Scipio; John E. Calhoun, Daniel Bacon, Brewersville; R. A. Johnson, Zenas; J. A. Grinstead, S. Elliott, Nebraska; Mr. Sutton, Joseph Hole, C. D. Shank and Harry Gibson, Butlerville.

RIPLEY COUNTY.

BY WM. W. BORDEN.

Ripley county was organized in 1818, and named in honor of Gen. E. W. Ripley, an officer of the war of 1812, and is bounded on the north by Decatur and Franklin, on the east by Dearborn and Ohio, south by Switzerland and Jefferson, west by Jennings.

This county contains 450 square miles, with a total area, according to assessment, of 279,165 $\frac{98}{100}$ acres.

Enumeration of children for schools, in 1870, was 7,613; in 1875, 7,937.

The largest part of the county is level, and large areas, called "flats," are met with. The broken or rolling land borders on the streams. The drainage of the county is poor, excepting along the watercourses, where there is a local drainage, and the streams flow into the Ohio river on the east, and to White river on the southwest.

The principal streams of the county, are Big and Little Graham. The former rises near the summit of the Lower Silurian, in the central part of the county, and flows west of New Marion. The latter rises on the "flats," a little east of North Marion, and flowing over the Niagara rocks, to the southwest, unites with the main stream in Jennings county, and forms a junction with Big creek below Paris. The next streams of note are Big and Little Otter creeks, being thus designated above their junction, which occurs a short distance east of Butlerville. These streams are the head waters of the South Fork of the Muscatatuck. Big Otter creek rises in the "flats," a short distance southwest

of Napoleon, and flows over the Niagara rocks, and cuts the Lower Silurian at its junction with Little Otter, which rises in the "flats," southwest of Osgood. The North Fork of the Muscatatuck slightly washes Jackson township on the west. Laughery creek rises a short distance southeast of Napoleon, flows over the Niagara rocks to the north, and soon cuts the Lower Silurian formation. The flow is then east to its junction with Little Laughery at Ballstown, thence south and southeast, and finally north by east, into the Ohio river below Aurora. North and South Hogan flow from the eastern border of the county. There are numerous small streams, Cedar creek, Castaters branch, Pendleton creek, Ripley, Plum, Racoon and Tanglewood.

This county is well watered in the eastern part by constant springs and by numerous streams, also in the western division by the streams flowing with the dip of the Niagara formation to southwest. A water supply can be secured in any locality at a reasonable depth. The most broken or rolling section of the county is in the eastern or northeastern part, bordering on Laughery and the head waters of Hogan. These streams, coming in contact with the clay and shaly layers of the Cincinnati Epoch, which are very friable in some parts, soon cut down the strata to a great depth, which gives rise to a very rolling country with far-reaching vistas, as in Dearborn county to the east, or as along Laughery, which is comparatively a short stream, with precipitous bluffs of one hundred to two hundred feet, and a broad alluvial valley. Many of the prominent bluffs along the latter stream afford picturesque views.

Judging from the numerous mounds found on the border of this stream it was a favorite resort of a prehistoric race. Laughery creek was named after Col. Archibald Laughery, of Westmorland county, Pennsylvania, who was tomahawked and scalped near the mouth of the creek, and about forty of his men killed, when on their way to join the command of General Clarke, at the Falls of the Ohio. The party went on shore for the purpose of cooking some buffalo meat, when they were attacked by the Indians.

GENERAL SECTION OF RIPLEY COUNTY.

Quaternary Beds.

1.	Alluvium, recent		2 to 25 feet.
2.	Champlain	10	35 feet.
3.	Glacial Drift		

PALEOZOIC GEOLOGY.

The rock strata of this county comprise two members of the Upper Silurian, and one of the Lower Silurian Age, as follows:

UPPER SILURIAN AGE.

Niagara Period.

4.	Niagara limestone; stratified, gray and white, a good building stone, and when burned produces a good lime	42 feet.
	Clinton epoch	a trace.

LOWER SILURIAN AGE.

Trenton Period.

Cincinnati epoch	190 feet to ——

The oldest formation in this county belongs to the Cincinnati epoch,* and is more or less noticeable along most of the streams in the county, attaining on the eastern border an altitude of one to two hundred feet above the

*PROF. W. W. BORDEN:

DEAR SIR:—In your Report on the Geology of Jefferson county you place the line of division between the Lower and Upper Silurian rocks, at Madison, at the *Tetradium* beds, altitude 319 feet, and have, inadvertently, no doubt, credited me with it. Such, however, is not my view. In 1873, or earlier, I discovered a stratum bearing Hudson fossils, which lies 49 feet above the *Favistella* bed on Michigan road hill, and 351 feet above low water mark in Ohio river. It overlies 32 feet of non-fossiliferous limestone, the banded limestone of Owens' Report. This stratum I regard as the true boundary between the Lower and Upper Silurian rocks at this place. I gave notice to the public of this discovery in an essay on the Geology of the Madison hills, published in the *Indianapolis Journal* of July 10th, 1874, and which was copied into the Madison Courier within a day or two afterward.

I am, Dear Sir, very respectfully yours,

W. T. S. CORNETT.

Madison, Indiana, January 27, 1876.

beds of the streams. Commencing in the southwestern part of the county there occurs at New Marion, Shelby township, the following section, on B. D. Bacon's spring branch:

1.	Ocherous clay soil, with sand..................	6 to 10 feet.
2.	Niagara stratified limestone, gray, weathering rough, and shows brown streaks, from decomposed pyrites; also fossil crinoid stems. Strata 12 to 14 inches...	10 to 12 feet.
3.	White stratified limestone in strata of 14 to 16 inches, burns readily into lime, weathers very smooth where exposed...	20 in. to 2 ft.
4.	Stratified limestone, unevenly imbedded, thin layers, gray with brown spots.......	4 feet.
5.	Thin stratified gray limestone with clay partings and terminating in 6 in. clay shale below, with an abundance of crinoid stems....................................	1 ft. 9 in.
6.	Brown and gray stratified limestone, thin layers at the crop, with crinoid stems, *Zaphrentis*, *Calymene blumeubachii* and shells; also plates of *Caryocrinus ornatus*	6 to 10 feet.
7.	Thin, stratified, unevenly imbedded magnesian limestone, projecting and making water falls....................................	10 to 12 feet.
8.	Dark blue shale, containing aulopora stems, etc., and thin limestone layers, with Cincinnati fossils......................	5 to 6 feet.
9.	Dark blue, stratified limestone, with a trace of spar, three to 5 ledges, 8, 12 and 14 in.	4 to 5 feet.
10.	Dark shaly limestone to the bed of Big Graham	5 to 8 feet.

Higher up the stream, Graham creek flows over No. 10 of the above section, which forms a smooth bottom. No. 9, which superimposes it, appears along the shore, showing a uniform but rapid dip to the south and west. No. 2 of the above section forms cliffs along Graham, and frequently large detached masses occur, with trees growing upon them. An out-crop on the New Marion and Versailles road, at Graham creek, section 30, range 11, shows:

1.	Ocherous clay soil, brown and white chert, with a trace of sand and numerous small boulders.................................	6 to 10 feet.
2.	Magnesian limestone, rough..................	?
3.	White stratified limestone......................	?
4.	Not exposed.	

5.	Gray stratified limestone, crinoid stems, corals and shells	4 to 5 feet.
6.	Brown shale, with crinoid stems and corals	5 feet.
7.	Thin, stratified magnesian limestone	8 to 10 feet.
8.	Limestone	10 to 12 feet.
9.	Dark blue stratified limestone, 8 to 14 in	5 feet.
10.	Magnesian limestone to the bed of Big Graham	5 feet.

An abundance of sand for all ordinary purposes is found along the road-side and streams in this locality. A section on Big Graham at the crossing of the Marion and Butlerville road, shows:

1.	Light colored clay soil with darker shades at the bottom, and white chert	8 to 10 feet.
2.	Magnesian limestone, weathering rough	10 to 12 feet.
3.	White limestone, weathering smooth	2 to 4 feet.
4.	A course-grained limestone containing stems and crinoid roots	10 feet.
5.	Various grades of limestone	12 to 15 feet.
6.	Thin layers of hard blue limestone and shales, with Cincinnati fossils	10 feet.
7.	Dark blue and lighter shades of stratified limestone in strata of 12 to 14 inches, same as No. 9 of the above sections, contains pockets with calc spar	3 to 5 feet.
8.	Decomposing mottled magnesian limestone, cropping at low water and in the bed of the creek, Cincinnati	2 to 4 feet.

The dark blue stone of No. 7 and 9 of the above sections stands the weather well and is good for foundations. By reason of the rapid dip of this strata, a short distance below this point the stone disappears beneath the surface. These crops are nearly due east of Butlerville where sections have been obtained on the South Fork. From New Marion to Holton the "flats" intervene, and two miles southwest of Holton, on Otter creek, at the crossing of the North Vernon and Versailles road, this section occurs:

1.	Light colored clay, with darker shades at the bottom, sand and boulders in the ditches	10 to 20 feet.
2.	Gray stratified limestone, Niagara	12 to 20 feet.

3. White stratified limestone, good for lime...	15 to 25 feet.
4. Dark gray, shaly limestone, with clay layers and fossils, Cincinnati, to bed of creek..........	8 to 12 feet.

An abundance of crystalline Niagara limestone is seen in all this region along the bluffs. Some distance below this, on the land of S. Lane, section 8, above the railroad crossing of Otter creek, the following strata show:

1. Ocherous clay with sand, white and yellow chert and boulders..........	10 to 20 feet.
2. Grey stratified limestone, (Niagara), thick and thin beds	30 feet.
3. White stratified limestone in flagging layers, 4 to 7 in..........	12 feet.
4. One or more thin strata of coarse-grained limestone, a mass of fossil crinoid stems on the surface..........	5 in. to 12 in.
5. Dark and light clay shale, commencing the Cincinnati outcrop, thin layers of stone above	10 to 12 feet.
6. Otter creek marble, one or two layers of mottled or variagated, fine grained limestone, which takes a good polish and is suitable for inside ornamentation..........	1 ft. 8 in.
7. Shaly limestone to the bed of Big Otter creek..........	5 to 6 feet.

Southwest of Osgood, on Otter creek, the Cincinnati rocks are seen in the bluffs and on the rolling lands bordering Otter creek, and are thirty to forty feet thick, with the Niagara above, but as the country becomes more level in the direction of Napoleon, only the Niagara rocks are seen. This finishes the localities of the Lower Silurian in the western part of the county, and the section given will show the thickness of outcrop on the eastern border.

This formation (Cincinnati) shows a greater thickness in the eastern part of the county; and Laughery creek, which flows through the county from the northwest to the southeast, may be considered the boundary between the Lower Silurian and Niagara rocks; the greater portion of the out-crop east of that stream belongs to the former series.

In Brown township, in the southern part of the county,

about Cross Plains, there are extensive "flats" which form the water shed between Raccoon on the north, and Paw's branch, Indian-kentuck and Laughery creek on the south and east. The rocks seen in this section are mostly Cincinnati. The soil is a light-colored, siliceous clay. North of this, on Raccoon creek, the country is very broken, and the out-crop is chiefly Lower Silurian, as seen about the junction of this stream with Laughery a short distance above Hart's mill. The crop on Cæsar creek to the east is the same as the above. Also, on Laughery, above Hart's mill, in the vicinity of a large mound on the land of widow Praute, northeast quarter section 2, township 6, range 12, the bluffs here on Laughery show from one hundred and fifty to two hundred feet of the lower rocks. North of this point the same members continue to Versailles, the county seat. These crops give a broken appearance to the country, with elevated bluffs along the large streams. The bluffs on Laughery, above and below Versailles, are very abrupt in places, and present a good outcrop of Lower Silurian, with numerous rich fossil localities that are much resorted to by collectors. A section east of Versailles, on the Steinmetz land, shows from the high lands to the bed of the streams:

1.	Ocherous, siliceous clay soil with occasional boulders..............................	8 to 20 feet.
2.	Dark, granular magnesian limestone, massive in some localities........................	?
3.	Light blue stratified limestone, firm, in layers of 6, 9, 11, 14 and 20 in., with water markings on the lower face, sometimes cavernous................................	5 feet.
4.	Blue and light colored clay shales, with *Tetradium fibratum* (coral)..................	4 to 10 feet.
5.	Very hard blue limestone, thin layers, with shale and Lower Silurian fossils...	100 feet.
6.	Strata of blue clay shale, with layers of very hard blue limestone, containing *Rhynconella capax*, *Orthis sinuata*, *O. plicata*, *O. lynx*, varieties, *O. occidentalis*, *Strophomena alternata*; also, *Pleurotomaria*, *Murchisonia bicincta*, *M. bellicinta*, and slabs containing *Chætetes turberculata*.	

7.	Three or more layers of stratified limestone, and good slabs with *Leptæna sericea*...	3 to 4 feet.
8.	Blue shale, containing *Petraia corniculum* and *Rhynconella*.	
9.	Two or three inches of hard yellow shale, containing an abundance of pentagonal, round and square crinoid stems; also, *Heterocrinus heterodactylus*, *Hetrocrinus subcrassus*, Meek & Worthen, *Anadontopsis milleri*, *Asaphus gigas*, *and A. megistos;* in the blue shale below are also found *Orthis testudinaria*, *Strophomina striata*, *S. alternata*, and *Calymenes senaria*, to the bed of Laughery....................................	190 feet.

The strata at this point have a very perceptible dip to the southwest. On the bluff of the creek, a short distance above the latter locality, in company with C. B. Dyer, of Cincinnati, Ohio, collected a square celled coral, and a species of *Chaetetes*, *Strophomina alternata* and *S. striata* with a number of other characteristic fossils. Below this point and opposite the mouth of Cedar creek, we collected *Lachneocrinus dyeri*, *Orthis testudinaria*, etc. The land is very much elevated three miles north, about the head of Cedar creek, and a section at the Devil's Elbow, the highest point, shows:

1.	Ochreous clay, with white chert and sandy layers, large boulders of a variety of colors, and blue clay at the base...........	12 to 25 feet.
2.	A very hard, rough, flinty limestone......?	8 inches.
3.	Ocherous layers of various shades, and sandy beds, partially covered with debris...	9 feet.
4.	At the Falls, 2 to 3 strata of bituminous limestone, 6 to 8 in..................................	1 ft. 8 in.
5.	Shaly limestone to foot of the Falls..........	20 to 25 feet.
6.	Lower Silurian to the bed of Laughery creek	150 to 190 feet.

On the Versailles and Moore's Hill road, two and one half miles east of Versailles, on Pleasant Hill, in company with Dr. W. H. H. Hunter, I was shown a good fossil locality for *Tetradium fibratum*, curved in form, and occurs

near the top of the hill; also, a rare crinoid, *Lichenocrinus terberculatus*, and some other fossils are found here.

From the above locality east, the flats intervene to North Hogan, and between that stream and South Hogan the land is gently rolling; nearing the latter the land becomes very rolling. It is believed that the *Murchisonia* which occurs in the bed of Cedar creek, near the mouth, above Versailles, is near the summit of the hills, at Moore's Hill. Collected on South Hogan, near the railroad depot, *Strophomena rugosa*, *S. incurvus*, *Calymene senaria*, and many other good fossils. A good outcrop of the Cincinnati is met with on North and South Hogan. A section on the Versailles and Osgood pike, at the crossing of a branch of Cedar creek, shows the following crop:

1. Ocherous clay with a trace of sand and gravel	5 to 12 feet.
2. Show of white limestone containing crinoid stems, (Niagara).	
3. Yellow shales with dark layers	8 to 12 feet.
4. Dark-blue limestone, rough with corals.	
5. Dark-blue stratified limestone in layers of 8 to 12 inches, and terminating below in thicker layers with partings of shale,	16 to 18 feet.
6. Along the stream, Cincinnati rocks below.	

It will be seen from these sections, that the crop here is almost entirely Lower Silurian. East of Osgood the rocks are almost exclusively Cincinnati, and thus continues to the east in the direction of Delaware. On Laughery, below the mouth of Pendleton, and on the south side, the outcrop is as follows:

1. Ocherous clay soil with a trace of sand and boulders	20 to 30 feet.
2. Covered, (Cincinnati).	
3. Blue shaly limestone and clay layers; an abundance of Cincinnati fossils	25 to 30 feet.
4. Blue clay shale, with fossils *Petraia corniculum*	3 to 4 feet.
5. Thin blue limestone layers with shale containing *Strophomena alternata*, *Leptæna sericea*, parts of *Asaphas gigas*	20 to 25 feet.

Along Plum creek some thick strata of limestone occur in the Lower Silurian, but as seen in the piers of the railway bridge over Castater's branch, the Plum creek stone is not durable; but the Vernon stone, in the same abutments, shows no sign of disintegration. The land along Castater's branch is broken; flat land intervenes between it and Laughery on the west, but the country again becomes broken along the latter stream. At Blackmore mills, on Laughery, the following section is seen:

1.	Light colored clay, ochre shades below, with sand and large boulders..................	25 to 30 feet.
2.	Dark blue shaly limestone with Cincinnati fossils	150 feet.
	Orthis lynx, *O. dentata*, *O. sinuata*, *Trilobites;* 10 feet above the bed of Laughery.	

The outcrop in this section is exclusively Lower Silurian, as will appear from the following section on the State Road at J. T. Dashiell's, section 31, township 9, Delaware township:

1.	Clay soil, sand and boulders	5 to 20 feet.
2.	Stratified gray limestone, weathers white, in dark blue layers..............................	10 to 15 feet.
3.	Good layer of *Tetradium fibratum* and other fossils..	3 to 5 feet.
4.	Blue shale, and dark blue shaly limestone with fossils to Branch..............................	10 to 25 feet.

North of this, on the southern exposure, fragments of the rare fossil crinoid, *Lichenocrinus tuberculatus*, was seen. To the north of this, along Ripley creek, heavy beds of sand from the drift covers the outcrop of rocks and occasionally boulders of large size are met with. In this locality, about the mouth of Ripley creek, and above on Laughery, the drift is heavy, producing clay and sandy shores to the streams. The water courses here, abound in mollusca, which were seen plowing through the sandy beds of the streams. Large numbers were washed out, at the time of our visit, by the recent high water, and were destroyed in large quantities by hogs that range along the streams and feed upon them.

About Ballstown, in Laughery township, on Laughery creek, the land is broken as usual, but the bluffs are not so abrupt on its head waters as they are lower down the stream. An outcrop on the land of John Wilson, in this stream shows twenty to thirty feet of Lower Silurian rocks. To the west of this the Niagara comes in. Having traced the oldest formation in the county along Laughery to near the head-waters, almost the entire beds to the east of this are composed of Lower Silurian, with some firm and durable strata in the quarries about Milan, as follows:

1.	Clay, soil and sand	2 to 10 feet.
2.	Dark gray stratified limestone	2 to 4 in.
3.	Dark gray stratified limestone	6 to 8 in.
4.	Dark gray stratified limestone	18 to 20 in.
5.	Dark gray stratified limestone	14 to 18 in.
6.	Dark gray stratified limestone	18 to 22 in.
	Total	10 feet.

East of Milan on Hogan the land is very rolling. A quarry opened on the land of E. Shockly, section 19, township 13, range 8, and one mile northeast of the station, (South Milan) on the O. & M. railroad, shows as follows:

1.	Clay soil	2 to 6 feet.
2.	Blue stratified limestone	18 in.
3.	Blue stratified limestone	14 in.
4.	Blue stratified limestone	12 in.
5.	Flagging, blue limestone below.	

Adams township, in the northeastern part of the county, is principally flat, with but little outcropping rocks. Along Pipe creek, which rises on the "flats" at Sunman, and flows north into Whitewater, in Franklin county, a show of Lower Silurian rocks is to be seen, one mile west of Pennsylvaniaburg. A trace of Niagara was found on the most elevated lands near Sunman, which is five hundred feet above Lawrenceburg, on the Ohio river, and twenty miles distant by the I. C. & L. railroad. The clays are so deep and the land so flat, but little outcrop could be found. In the western part of this township, two miles south of Batesville, and on the head waters of Laughery creek, the

land becomes rolling, and stone is quarried at outcrop as follows:

1.	Light-yellow clay, sand and glacial drift below	12 to 30 feet.
2.	Two to three layers, flagging limestone, Niagara.	
3.	Thin layers of blue limestone, with Cincinnati fossils.	
4.	Thicker strata of blue limestone	2 to 5 feet.

Extensive quarries of white limestone, (Niagara), are worked to the west of this, in Decatur county, and especially at Greensburg, and on Flat Rock creek, in Shelby county.

I have traced the oldest formations seen in the county, from an exposure in which it is represented by only a few feet of strata, to where it has reached a development of about 200 feet, on the eastern and northeastern borders of the county. The sections obtained in these localities show a succession of limestones, shales and clay (matrix of *Tetradium fibratum*), the whole capped in some places with dark blue, close-textured, thick-bedded limestone. This section is succeeded by strata belonging to the Upper Silurian age, and the prevailing fossil forms of the preceding age give place to new and well marked types, which serve as guides for the classification of the strata.

NIAGARA EPOCH.

It will be seen from the sections hereafter given, that the Niagara limestone is in considerable force in the southwestern part of the county, on Graham and in the western part, on Otter creek. A good outcrop is seen along Little Graham, from its junction with the main stream at San Jacinto, in Jennings county, to the head waters of that stream, one mile south of New Marion, on the land of Daniel Holman, section 1. In this locality the stream flows over thin layers of limestone, with the dip of the rocks, which is considerable, to the southwest. These rocks contain some fossil stems, and an abundance of *Othoceratites* from 6 inches to 3½ feet in length, and 2 to 3 inches in

diameter, others of great length but of small diameter. They are very much abraded, and good specimens could not be obtained for the cabinet.

Werkable beds of Niagara limestone are found on Tanglewood and the head waters of Big Graham, in Johnson township, section 15, three miles southwest of Versailles, on the land of John Jackson, Sen. At the quarry, at present worked by him, there occurs the following layers of compact, light gray limestone:

1.	Loamy soil	0 to 3 feet.
2.	Five ledges of stratified, light gray limestone, Niagara, 4 to 5 in each	1 ft. 6 in.
3.	Sixth ledge	6 in.
5.	Nine ledges, 4 to 5 in. beds, as far as worked, with some heavier layers below	3 ft. 5 in.

This stone is quarried and worked for steps, flags, sills, etc. Mr. Jackson also burns this stone for lime, using wood for fuel, and sells lime at the kiln at 20 cents per bushel. This quarry is three miles south of Osgood, where the same stone is worked, with some thicker layers by Messrs. Ashman & Glasgow, in Center township, section 28, on the O. & M. railway, and shows as follows:

1.	Light colored clay, and terminating below with blue clay, sand, gravel and boulders	2 to 6 feet.
	(NIAGARA.)	
2.	White stratified limestone in layers, as follows: one ledge, 7 or 8 inches, ("Flat Rock") burns into good lime; 3 ledges —one 7 inches, and two ledges 6 inches	26 to 27 in.
3.	White stratified limestone	7 to 8 in.
4.	White stratified limestone	4½ in.
5.	White stratified limestone	6 in.
6.	White stratified limestone, with fossil *Orthocerata*, many layers	4 in.
7.	White stratified limestone, with fossil *Orthocerata*, many layers	7 in.
8.	White stratified limestone, with fossil *Orthocerata*, many layers	5 in.
9,	White stratified limestone, with fossil *Orthocerata*, many layers	7½ in.
10.	Stratified limestone continues as far as worked	6 to 7 feet.

Ashman & Glasgow employ on an average about 25 hands when the weather is suited for out-door work. This stone is easily worked, and is free from cherty concretions or spar, and when dressed has a very white appearance. It is cut into coping, ashlers, curbing, gutter flags, also for cellars and sidewalks. The principal market for this stone is Cincinnati, where large quantities are sold. The Niagara limestone outcrops to the west of this on the head waters of Otter creek and continues to Napoleon, in Jackson township. It is exposed on the head waters of Laughery creek, which rises in the "flats" south of Napoleon, and flows north.

1.	Light colored clay soil, with ochre shades below, sand and an occasional boulder..	4 to 15 feet.
2.	Blue and gray mottled limestone, in layers 14, 10, 8 and 3 inches; it has a rough surface as at Flat rock, and is in all......	15 to 20 feet.
3.	Light-brown stratified limestone, with crinoid stems, and fragments of Trilobites, *Calymene blumenbachii*, also occasional clay layers..	8 to 10 feet.

A short distance east of this Laughery creek flows over the summit of the Lower Silurian, but before its junction with the Ohio river, below Aurora, has cut down the Cincinnati rocks to a great depth. The elevation by railroad levels, at South Milan, in Franklin township, on the O. & M. railway, is 507 feet above the Ohio. An abundance of good building limestone, (Niagara), crops about Napoleon, and is easy of access. Quarries could be opened at many localities, which would afford good stone for foundations, superstructure, flagging or for lime, but there being no demand for stone at this place, and no facilities for transportation, this interest lies dormant. Having traced the Niagara formation for three seasons past, from the Falls of the Ohio, in Clarke county, where it is marked by the chain coral, *Halysites catenulata*, and at Utica, in the same county, by *Caryocrinus ornatus*, and many other fossil forms, I find the beds to be very uniform, and charged with characteristic fossils throughout its course, *Othocerata* being

especially abundant. The Niagara rocks thin out to a line on the east, where they lap upon the Lower Silurian.

This survey has shown the eastern border of the sub-carboniferous to be in Floyd, Clarke and Scott counties; the Devonian in Jefferson and Jennings, and lastly, the Niagara in Ripley county, while to the east are heavy beds of Lower Silurian.

QUATERNARY.

The Quaternary beds in this county rest immediately on the Paleozoic rocks, which are Cincinnati and Niagara. The thickest beds of glacial sand and clay, with boulders, are to be found in the northern part of the county. Numerous hills of yellow sand occur in the northeastern part of Adams township, near the county line bordering on Dearborn and Franklin counties. These sands lie quite evenly bedded, showing dark and lighter shades of color, and are from ten to fifteen feet in thickness, and in some localities covered with thick beds of clay. Good beds of brown sand are seen along the sand ridge on the land of John Schlicht, four to five miles north of Sunman, near the Dearborn county line, section 32, range 13. The drift is of moderate thickness along Plum creek, in this township, composed of sand and boulders. Evidences of glaciation are to be seen over the entire county, and doubtless the Paleozoic rocks will be found marked by the abrading forces then at work. The cutting away of solid rock strata is evident from what is developed by the well at South Milan, on the O. & M. railway. In this locality, heavy beds of very hard limestone are at the surface, (see section at quarry of E. Shockley, above given). These limestone beds are very continuous about South Milan, and some quarries are opened on the "flats" adjoining the town. The O. & M. Railway Co. had occasion to sink a well at this place for a water supply, and the following is a section of what it passed through:

1.	Light colored clay soil	10 to 14 feet.
2.	Yellow clay, with flint gravel and fossil corals	12 feet.
3.	Blue glacial clay	12 feet.

4.	Coarse yellow sand with recent shells and water	8 feet.
5.	Blue clay, muck, containing roots and limbs of trees	8 feet.
	Total of	54 feet.

Without reaching stone, as has been shown, compact beds of limestone occur in the immediate vicinity.

Here we have evidence of a deep glacial cutting that was subsequently filled by deposits of the Champlain period. There are extensive "flats" in this county about the head waters of Laughery creek and to the west of that stream, and lying between the head waters of Otter creek, Graham and other streams. The "flats" are composed of a light colored surface clay, with a trace of sand, and terminating downwards in clay of various shades of color. An average section of this deposit was obtained at Henry Dawson's. He is mining clay for the tile and brick works of R. W. Smith and H. Dawson, at Sunman, Adams township.

1.	Light colored clay with a trace of iron, used for brick	3 feet.
2.	Light blue to deep blue, used for tiles	4 feet.
3.	Ocherous shades with blue	2 to 3 feet
4.	Blue and yellow, clear blue sand with water	?

The clays of this period throughout the county have the same general appearance, with a trace of black sand, which is to be seen in streaks and in the washings on the road-side. It readily adheres to the magnet when dry. The alluvium found along the streams or hillsides is the result of the weathering of limestones and shales of the Niagara and Cincinnati epochs, decayed vegetation and the sand and clays of the glacial drift. This commingling of various strata forms a highly productive soil.

ANTIQUITIES.

More than the usual number of pre-historic relics are found in this county, comprising stone axes, arrow points, spear heads, knives, fleshers, and ornaments of various forms. I have discovered in this county, over twenty

mounds of various sizes and shapes, principally along Laughery creek, which flows through the county and empties into Ohio river, below Aurora. It is not surprising that along so large a stream as this, with elevated bluffs, and in close proximity to the Ohio river, pre-historic works should be abundant. It is worthy of note, that there is a greater variety of structure in these mounds than in the counties on the south. In company with James W. Pate, County Clerk, and others, I visited a large earth mound in Brown township, one mile north of Hart's mill, east bluff of Laughery, northeast quarter, section 2, township 6, range 12, land of widow Praute. This mound is some seventy-five feet in diameter at the base, and, as I was informed, was originally fifteen to twenty feet in hight, but at the time of our visit, measured near twelve feet. The owner of the land had recently attempted to plow it down. This earth mound was opened by some parties a few years since, and found to contain animal bones, mussel shells, ashes, coals and glazed pottery. I was informed by Wm. L. Cornell, a very intelligent man who settled here in 1818, but came west from Fayette county, Penn., as early as 1803, that eighteen rods west of the large mound, there was another mound covered with stones in which human bones were found. Mr. Cornell also informed me that he and his son, some years ago, opened a vault, some forty rods southeast of the large mound mentioned above. This vault was covered with loose stones, resting on a covering of flag-stones, laid with broken joints so as to exclude the soil. Upon removing the covering they found three skeletons lying east and west. The length of these skeletons was respectively five feet, four and a half feet, and three and a half feet. Another mound, one hundred rods from the large mound, also covered with stone, contained human bones. At the time of my visit we opened an earth mound, three-eighths of a mile southwest of the large mound. This mound was sixty feet in diameter, and found to contain nothing but a few arrow points. A short distance west of the latter we opened a flat mound, made by

setting stones on edge, and forming a hollow space in the center, in which we found fragments of human skulls, and other animal bones. This is, perhaps, the most noted cluster of mounds in the county, and all traces of them will soon be lost. The bluffs of Laughery, on which the large mound is located, are very elevated, and afford a commanding view; the stream is seen wending its way to the south, along the base of the bluffs, which are lined with dense forests, and fertile alluvial lands.

Another earth mound, 66 feet in diameter, is to be seen in this township, section 28, and three quarters of a mile southeast of Cross Plains, on the land of A. Rowe; numerous flint chips were seen here, and a few flint arrow-points collected. The greater part of the implements found in this county are made of the native chert.

Two miles below Versailles, section 12, land of J. Warman, there is, on an elevated bluff of Laughery creek, an earthwork of quadrilateral form, with the parallel sides slightly deviating from north and south. The earth is thrown up from the center, and the walls are two feet high on the inside, and three feet on the outside; length of the walls 30 and 40 feet on the outside, and 15 and 20 feet on the inside. The view from here is, as usual, very good, and overlooks another earth mound in the valley below.

East of Osgood, below the mouth of Plum creek, in company with J. M. Roberts, I examined a circular embankment situated on a second bottom of Laughery creek, which measured about 360 feet in circumference. The earth is thrown from within, leaving an elevation in the centre, which is connected with an entrance-way from the north. The grounds around are strewn with flint chips. Some other conical earth mounds are found within a half mile of this. In company with J. T. Dashiel, I examined an earth mound on Laughery above the mouth of Ripley creek. This mound had previously been opened and found to contain bones and charcoal, with large boulders. We also examined an earthwork on the bluffs of Ripley creek, rather

elliptical in shape, and measured near 300 feet in circumference on the center of the embankment, which is 12 feet at the base. Here the earth was also thrown from the inside, leaving a raised center which, connected with an entrance-way from the west. This earthwork was located in a very dense forest swarming with mosquitos, and the ground is thickly covered with ferns, of which I collected the following varieties: *Aspidium angustifolium, Aspidium* (?), *Phegopteres hexagonoptera* (?), *Adiantum pedatum* (?), *Phegopteris cystopteris* (?), *P. polypodiodes.*

In company with Dr. William H. H. Hunter, I visited a rather unique mound on a high bluff, a short distance southwest of Versailles, and located on the old Hunter farm. This work was composed of stones set on edge, and near the form of a cross; also, some upright stones, rising one above another like steps. An earth mound was seen in the orchard on the second bottom below. An earth mound of considerable dimensions is situated in the cemetery at Versailles. A short distance above this locality at "Prospect Spring," which issues from near the summit of the bluffs, and furnishes a constant flow of cool water, on the land of Mrs. J. H. Smith, mound builders' relics are frequently found, which leads to the inference that this was a favorite camping ground.

In company with Wm. M. Pullaim, I examined a mound on the land of Elijah Stark, east of Versailles, situated on the bluffs of Cedar creek. This is an earth mound, 45 feet in diameter, and recently opened by Mr. Pullaim, who, at the depth of about four feet, exhumed human skull bones partially burned, samples of which I saw. He also found in the mound several inches of ashes, with charcoal. It is impossible at present to give more than a short sketch of a few of the numerous mounds found in this county. Altogether, this is an interesting field for the study of pre-historic works.

AGRICULTURE.

The usual farm crops of the State are cultivated in this county: corn, oats, wheat, grass, potatoes and buck-wheat.

The agriculturists of this county have two distinct grades of farm lands. First, on the "flats," so-called, a retentive clay soil, with but a few inches of vegetable mold. This land is a cold, compact, tenacious clay, with a little sand in some parts. These lands should be under-drained to render them productive. Second, lands that are made up from the weathering of limestone, drift, clay and sand, and vegetable mold. These lands constitute the most productive in the county. The drainage here is better, and the soil being porous, it is not so much effected by excessive drouth or rains. The bottom lands along Laughery creek are a detritus of the Lower Silurian, and are of remarkable fertility.

Hops are grown in some of the northern townships of the county, but formerly more extensively than at present. G. W. Perine, in Delaware township, a short distance from Rei Station, O. & M. Railway, cultivates several acres of hops. Other farmers in this township also cultivate a few acres. Adams township was formerly the most extensive field for hop culture, and a considerable area is still devoted to that object. Hops are planted like corn, but in much wider rows and are stuck with three poles, 14 to 16 feet in length, to the hill. A planting of hops will last for several years. They are cultivated like corn, by plowing and hoeing. The yield per acre is from 200 to 700 pounds, rarely 1000 pounds. The average yield is about 500 pounds per acre. The price varies from ten to fifty cents per pound, baled. I heard of one extra crop raised some years ago that gave 11,000 pounds from nine acres and brought in the market 12½ cents per pound. Rolling land with a deep, loose, clay sub-soil is considered the best for the growth of hops. The grub is found troublesome about the roots of plants of long standing.

Buckwheat is also extensively grown in this county, and a large area was sown this season on account of the failure of the wheat crop. This grain blooms late and affords a good resort for bees.

TIMBER.

Ripley county had, originally, a very heavy growth of timber. In sections of the northern part, the growth is almost exclusively white oak; in other sections, exclusively beech, while in other localities the two are combined and interspersed with other varieties. The forests on the "flats" are remarkable for the abundance and size of the trees and the occasional thick undergrowth, woven together with grape vines which add much to the density of the woods. The cutting of white oak for staves has deprived these forests of their best timber, yet some scopes of wood which have been preserved bear testimony to large and abundant growth of the primitive forests. The timber on the rolling land and along the streams, are poplar, black and white walnut, white oak, black oak, water oak, gum, hackberry, ash, water maple, elm, sycamore, etc.

There are a number of saw mills throughout the county. I am indebted to Mr. J. L. Stiles, manufacturer and wholesale dealer in lumber and in heavy timber, at Milan, for the lumber products of the county. There are at present, in the county, twenty saw and twelve grist mills. The approximate amount of lumber cut during the past year, is 2,000,000 feet, or, 100,000 for each mill. J. L. Stiles, with two mills, has cut about 300,000 feet. The depressed market for lumber has resulted in a much less amount cut this year than in 1873, when it was estimated at 5,000,000 feet.

List of saw mills: Daniel Stevenson & Sons, Sunman; Jacob Walters, Sunman; John Gro, Rei; Sage & Bro., Rei; M. Clark & Bro., Rei; C. A. Kenlog & Bro., Milan; J. S. Jorden, Pierceville; O. T. Googins, Pierceville; T. & W. D. Wilson, Osgood; Wm. Sheem, Holton; Mr. Henten, Holton; J. Pearsons & Bro., Versailles; Thompson & Alexander, Milan; Degner & Co., Elrod; B. Heaton, Elrod; Joseph Jackson, Delaware; Mr. Thackery, Ballstown; J. L. Stiles, one heavy and one light steam saw mill.

CONCLUSION.

In conclusion thanks are due to the citizens of Ripley county for courtesy and assistance in my work. The following named, rendered special aid: Benjamin F. Harrell, Benjamin D. Brown, of New Marion, Shelby township; Lewis Roszt, County Commissioner, Henry Schmolsmire, John Sweazy, M. D., Alpheus Hunter, Cross Plains, Brown township; Dr. Wm. H. H. Hunter, James W. Pate, County Clerk, J. B. Rebuck, Attorney at Law, Wm. M. Pullaim, C. C. Bryant, John H. Wernke, Auditor Ripley county, Versailles, Johnson township; R. W. Glasgow, Robert Young, J. B. Foy, J. M. Roberts, Osgood, Center township; C. B. Johnson, Napoleon; Dr. Clark, Rev. Wm. H. Burton, J. H. Drake, M. D., J. T. Dashiel, G. W. Perrin, Rei, Delaware township; D. B. Abbott, M. D., E. Shockly, J. L. Stiles, Milan, Franklin township; A. Hazen, Richard W. Smith, Henry Dawson, John Schlicht, Herman Nieman, Dr. Davis, J. Severinghouse, Esq., Adams township.

ORANGE COUNTY.

PROF. E. T. COX,

State Geologist.

DEAR SIR:—We herewith submit a Report of a Geological Survey of Orange county.

Thanking you for valuable aid, and for many courtesies, we are Yours,

M. N. ELROD, M. D.

E. S. McINTIRE, M. D.

Orleans, Ind., December 30, 1875.

DESCRIPTION.

Orange county is one of the second tier of counties in the southern part of the State. It is nearly square, and has an area of four hundred square miles. It is bounded on the north by Lawrence, on the west by Martin and Dubois, on the south by Crawford, and on the east by Crawford and Washington counties.

Topographically it may be divided into two divisions, corresponding to the St. Louis and Chester formations. The first district, embracing the northeast part of the county, is comparatively devoid of hills, but much cut up and broken by the sinkholes and basins so peculiar and characteristic of the concretionary limestone regions of Lawrence, Washington and Harrison counties of this State, and parts of Kentucky. These basins are not so

deep as to seriously interfere with farming, and lend variety to an otherwise monotonous level. Along the banks of Carter's creek, and between Carter's creek church and Lost river, is a range of moderately high bluffs that are, to a certain extent, the counterpart of the St. Louis limestone hills of Sugar creek, in Lawrence county. The second division, embracing the southern, western and central parts of the county, is hilly and broken. Some of these hills rise to an altitude of three hundred feet above the neighboring valleys. Much of this district is cut up by ranges of high ridges that follow the course of the creeks and rivers, and few gaps of communication are open from one valley to another. The scenery is wild and picturesque. The high, castellated bluffs of sand and the lichen-covered rocks of massive limestone awaken in the beholder feelings of awe at the vast power that has, in past ages, been brought into action in eroding and excavating the deep valleys he sees on every hand. Where once the waves of a mighty ocean beat, there is now but the gentle murmur of some rivulet. Beautiful views of the surrounding country may be had from the hill-tops in the vicinity of Orangeville, Paoli and French Lick, and few other regions of country furnish such cozy and healthful nooks in which to build pleasant homes.

NATURAL DRAINAGE.

Patoka and Lost rivers, and their tributaries are the principal streams. Their general course is from east to west, while the course of their tributaries is from northeast and southeast to northwest and southwest. The range of high lands and ridges, as may be seen on the map, running from east to west through Jackson, the north part of Greenfield and Southeast townships, form the divide between the headwaters of these two streams. Patoka rises in Stamper Creek township, and drains the southern third of the county, and empties into the Wabash, below the mouth of White river. Its principal tributaries in the county are Cane creek and Young's creek and Golden's

creek on the north, and Grimes' creek on the south. Tucker's creek empties into it at the bend above Newton Stewart's farm, in Crawford county. Lost river and its branches, Carter's creek, Lick creek, and French Lick creek drain the central and northern parts of the county. It rises in Washington county, and empties into the East Fork of White river, in the southern part of Martin county. Lick creek is the largest tributary. It and French Lick creek are the tributaries from the south, with the exception of Lost river, above the first sink and Stamper's creek, that have their sources in the St. Louis limestone. All the principal springs of the county break at the top of the lower and middle Chester limestones, and being charged with carbonate of lime, are known as hard waters. None of these streams are of very great economic importance, yet several flouring mills are in successful operation on Patoka and Lost rivers. With good dams and machinery that would utilize all the power, they might be made much more profitable.

GENERAL GEOLOGY.

The rocks of Orange county all belong to the great Carboniferous Age or Age of Coal Plants, and to the Subcarboniferous period, except a narrow belt of Carboniferous conglomerate, the base of the true coal measures found on the west side of the county.

The strata dip from east to west, with a slight bearing to the south. The dip is not quite uniform; for miles it appears to be at the rate of fifteen feet to the mile. Exceptions may be seen in the north side of the hill, west of French Lick springs, where the dip is to the west at the rate of one hundred feet to the mile, and on the bank of Lick creek, on the road from Paoli to Vincennes, where it is to the east, but these are only local irregularities. The oldest rocks are found in the northeast part of the county, hence, in passing from east to west, we advance successively from the lower to the higher or more recent deposits.

The subjoined connected section is made from local sections taken at isolated points on or near the course of Lost river and Lick creek. The numbers in the first column refer to the general divisions, while those in the second refer to the local sub-divisions. References by number in the following pages refer to the general divisions of the first column.

CONNECTED SECTION OF ORANGE COUNTY.

Quaternary, or Age of Man.

		Ft.	In.
1.	Alluvium and soils	10	00
2.	Lacustral and drift	25	00

CARBONIFEROUS AGE.

Carboniferous Period.

		Ft.	In.
3.	Conglomerate, or Millstone epoch.		
	1. Coarse sandstone, locally filled with pebbles, heavy bedded or friable	40	00
	2. Coal, probably Coal A	1	06
	3. Sandstone, or shale	60	00
	4. Siliceous iron ore	5	00
	5. Massive sandstone, irregularly bedded and at the base filled with leaves and stems of *Stigmaria*	20	00
	6. Whetstone grit, fine grained, even bedded, with shaly partings, the lower member highly fossiliferous. *Paoli vetusta*, *Lepidodendron obovatum*, Sternb. *L. Valtheimianum* Sternb. *L. dichotomum*, Sternb. *Sphenopteris latifolia* Brgt. *S. tridactylis*, Brgt. *Neuropteris Smithii* Lesq. *N. Elrodi* Lesq. (sp. n.) *Stigmaria*, *Cordaites*, etc	24	00
	7. Shale, with fossils	2	00
	8. Coal, with underlying fire-clay	1	00
	9. Shaly sandstone	3	00
	10. Massive sandstone, locally glass sand, where sufficiently firm, grindstone grit	35	00

SUB-CARBONIFEROUS PERIOD.

Chester Group.

4. Chester limestone. No. 3 or upper.		
1. Limestone, cherty at the top. Fossils—*Athyris subtilita, A. Royissii, Pentremites pyriformis, Archimedes Wortheni, Zaphrentis spinulosa, Spirifer lineatus,* and *Producti*	17	00
5. Chester sandstone. No. 3 or upper.		
1. Heavy bedded and massive, locally the true grindstone grit, in some places red and blue shales near the base	105	00
6. Chester limestone. No. 2 or middle.		
1. Massive and heavy bedded. Fossils same as upper	25	00
7. Chester sandstone. No. 1 or lower.		
1. Heavy bedded or shaly, red or blue	5	00
2. Coal, generally persistent		04
3. Sandstone or shale, locally quarry-stone and flagging. Fossils—*Stigmaria* leaves and stems	30	00
8. Chester limestone. No. 1 or lower.		
1. Limestone, massive and heavy bedded, locally quarry-stone. Fossils—*Pentremites pyriformis, Terebratula bovidens, Bellerophon carbonarius, Rhynchonella subcuneata, R. mutata,* Trilobites, etc	50	00
2. Chester chert, non-fossiliferous	1	00
3. Limestone, locally lithographic. Fossils—*Spirifer striatus, Terebratula bovidens, Rhynchonella subcuneata, Syringopora mult-attenuata Producti,* etc	40	00

ST. LOUIS GROUP.

9. Chert.		
1. Highly bryozoic. Fossils—*Productus cora, P. semi-reticulatus, Bellerophon levis, Dentalium primarium, Athyris ambigua, Platyceras* (sp.?) *Zaphrentis spinulosa, Hemipronites crenistria, Spirifer striatus, Allorisma, Pinna, Lithostrotion Canadense, L. proliferum,* and *Chænomya rhomboidea?*	3	00
10. Conretionary limestone.		
1. Locally an even bedded, magnesian firestone, at other points massive and concretionary. Fossils much same as chert	50	00

11.	Limestone, locally cement	3	00
12.	Porous limestone	4	00
13.	Argillaceous limestone, hydraulic	15	00
14.	Cannel coal	a trace.	
15.	Bituminous limestone	10	00
	Total	583	10

LOCAL GEOLOGY.

St. Louis Group.

The St. Louis limestones and cherts are the surface rocks of the northeast part of the county and embrace an irregular area of about seventy-four square miles, within which are included the whole of Northeast, much the larger part of Orleans, the northeast corner of Paoli and the northern part of Stamper's Creek townships. The region of country under consideration, is broken by a range of bluffs that set in at the first sink of Lost river and run up Carter's creek to Carter's creek church, and thence south to Lost river. These bluffs vary in hight from forty to fifty feet, and seem to be a continuation of the group of Lower Chester limestone hills shown on the map as occuring in the southeast part of Orleans township. It is not probable they are the anticlinal of an upheaval but the result of a general system of erosion to which the whole county has been subjected, and as they form the southern limits of the Lacustral clays of Northeast township and determine the course of Carter's creek, it is reasonable to suppose they were in existence prior to the close of the drift period. Besides the bluffs, the surface of the country is broken by peculiar basin-shaped cavities known as *sinkholes*. These basins vary in depth from a few inches to forty or more feet and from a few yards to five acres in area. The larger ones invariably show broken fragments of chert on the sides. Usually this exposure of chert is much the most conspicuous on the northern and eastern parts, while the other sides have the greatest depth of soil and clay.

A peculiar feature of the country covered with sinkholes, is the absence of springs and brooks or any continuous system of surface drainage. The excess of rain-fall would accumulate in the basins and form ponds were it not that they nearly all have subterranean channels through which the excess of water is carried off. When these openings become closed, lasting ponds are formed, and this is very liable to be the case, after the surrounding lands are put under cultivation, from the wash that is carried into them from the adjoining slopes. Especially is this the case along the roadsides and in old fields where the wash is largely mixed with red clay that soon forms an impervious bottom. The remedy is to keep the original underground channel open.

The lithological characters of the St. Louis rocks are extremely variable, changing within a few yards, so that no two sections will give exactly the same results. The age and relative position of each strata can only be determined by its fossils, and this is often rendered much more difficult by their absence. It seems, however, that the strata becomes thicker and more uniform both in structure and fossils as we advance to the west.

As it is only the upper members of the St. Louis group that are seen in Orange county, we did not have an opportunity to determine the exact succession of the strata, and their relations in the outcrops in Lawrence and Washington counties. The solving of this question is rendered more difficult by the clays and sands that cover the older rocks and prevent the study of the strata in any direct line of exposure. But from an examination of the southern part of Lawrence county, in Bono township, we found that the highest and most recent rocks seen north of the lacustral clays and within one mile of the county line, were the Vermicular limestones of Prof. Collett. The Bedford limestone occupies a still lower geological horizon, immediately under the Vermicular, and can be had in vast quantities from the banks of Sugar creek. It is to this region the

people of the northeast corner of this county should look for good building stone.

The bituminous limestone, No. 15 of the connected session, is seen on the west bank of Carter's creek, on the farm of C. Weires, section 32, township 3 north, range 1 east, at which place the following section was made:

SECTION NO 1, CARTER'S CREEK.

Covered space.	
Argillaceous limestone, hydraulic	12 ft.
Cannel coal seam, No. 1 of connected section	trace.
Bituminous limestone	10 ft.
Total	22 ft.

At this place, and on the farm of J. M. Greenslade, near the county line on Lost river, the bituminous limestone is an even, heavy-bedded stone of a dark bluish or black color that emits a feted odor when struck with the hammer. On exposure to the weather it exfoliates and splits into thin laminæ. It outcrops in the deep holes along the bottom of Carter's creek down to Island church, and down Lost river to Trimble's grave yard. The next stratum in ascending order is a thin seam of impure cannel coal, ranging from a mere trace to four inches in thickness. Along Carter's creek it is constant. Near Island school house, during high water, it is washed up from the bed of the creek, and as it burns readily when thrown on a blazing fire, many persons have supposed that by digging into the bluff it would be found in paying quantities. As no workable beds of coal have heretofore been found so low down in the geological scale as this, time and money spent prospecting will only result in disappointment.

Above the coal trace next in order comes the argillaceous limestone, No. 13 of the connected section: At its base, on Carter's, it is a compact, thin-bedded, grayish stone, having a sub-conchoidal fracture that indicates hydraulic properties. On Lost river it is more earthy, and at the Trimble farm has an exposure of over thirty feet. At the farm of E. Elliott, section 6, township 2 north, range 1 east, it has

a thickness of fifteen feet, and in the middle and top portions is very earthy, equal to rotten stone, that may be of local value as a polisher. The subjoined section was made above the spring at this place:

SECTION NO. 2, CARTER'S CREEK.

Slope, with fragments of chert, thin bedded stone, No. 11 of the connected sections, fossils, valves of *Spirifer* and *Retzia*	3 ft.
Porous limestone, No. 12 of the connected section	4 ft.
Argillaceous limestone, No. 13 of connected section	15 ft.
Total	22 ft.

No well preserved fossils were seen except in the chert. In the argillaceous strata we found a large cast of *Bellerophon*. A few pieces of a dark flint stone, filled with the peculiar little fossils so abundant at Spergen hill and other places in the lower beds of the St. Louis group, were found. The porous limestone here seen has much the appearance externally of the Vermicular of Lawrence county, but is a softer, earthy stone. It will not make good lime. In fact, none of the stone seen in this region will prove of much economic value, unless as a cement rock. The lithological characters of the strata change rapidly in passing down Lost river and Carter's creek, so that at the bluff east of Nebo, while the thin-bedded stone No. 11 still retains its appearance, the other members have become much more compact. Opposite the bluff, a stone, the equivalent of the argillaceous, has been quarried for foundations of houses, but is too soft to stand the weather. At the crossing of the Orleans and Livonia road, on Lost river, all the strata have become compact except the porous limestone, at which place we made the following section:

SECTION NO. 3, FORD OF LOST RIVER.

Slope, containing fragments of chert with fossils, *Lithostrotions*, *Producti*, *Bellerophon levis*, *Dentalium*, etc.	16 ft.
Concretionary limestone, No. 10 of the connected section, with numerous fossils, *Productus cora*, *Spirifer*, plates and spines of *Archæocidaris Wortheni* and crinoid stems	24 ft.

Porous limestone, No. 12 of the connected section......	6 ft.
Compact limestone, No. 13 of the connected section...	10 tf.
Total	56 ft.

The concretionary limestone of the above section might, with equal propriety, be called *Bryozoic Dentalium*, or lithographic limestone. If we correctly interpret Prof. Cox's remarks in "Geological Survey of Indiana, 1870," page 139, this is the equivalent of the lithographic stone of Harrison county. Here it is massive stone of a grayish color, generally breaking with a chonchoidal fracture, and in texture presenting the characters of a lithographic stone. The concretions found in it are in thin, flat plates or nodules. The rounded forms are without fossils, and correspond to the amorphous geodes of Prof. Collett, in his report on the geology of Lawrence county. They are of all forms and shapes, and frequently present a striking resemblance to the head of some animal or a fruit. The laminated form occurs in irregular masses, ranging from a few lines to two or more inches in thickness, and from one to three feet in diameter. They are of a darker and more flinty appearance than other cherts, and are nearly always fossiliferous. This strata is the limestone generally met with beneath the chert and soil at Orleans, and in Orleans, Paoli and Stamper's Creek townships. It is the limestone exposed over a belt of country varying from four to five miles wide, running from Orleans towards Livonia. Good exposures may be seen on Lost river, east of the farm of James A. Frost, in section 2, township 2 north, and range 1 west, and at the railroad cut east of Orleans. Below the third sink of Lost river it becomes more magnesian, is almost destitute of bryozoans, and scarcely ever lithographic. At the fourth sink of Lost river, on the farm of B. C. Elrod, the following section was made by Prof. Richard Owen, in his Geological Survey of Indiana, 1859–60, page 143. It is here inserted for comparison, and as exemplifying the changes and differences in this strata at different points:

SECTION NO. 4, AT FOURTH SINK OF LOST RIVER.

General level of surrounding farms	25 to 30 ft.
High water mark	6 ft.
Chert in loose masses on river bank	2 to 4 ft.
Crystalline limestone	8 to 10 ft.
Thin shales and detritus	10 ft.
Soft magnesian limestone	46 ft.
Lithostrotion limestone	8 to 18 ft.
Disappearance of the river	8 to 10 ft.
Subterranean level near the gulf, above the sea	430 ft.

From the same author we learn that, according to Col. Stansbury and Mr. Williams, the court house at Paoli is 599 feet above the level of the sea, and consequently 169 feet above the sink of Lost river.

Producti and *Spirifer striatus* were noticed in all the strata, together with fragments of *Archæocidaris Wortheni* in the upper crystalline member, and *Lithostrotion Canadense* in the chert. Outcrops of a still darker and less fossiliferous stone, of the same horizon as that under consideration, may be seen at the cave spring, at the crossing of the Orleans and Vincennes road, on the dry bed of Lost river, and at the Wesley Chapel gulf. The top member of the concretionary limestone, at many places is very evenly bedded, the laminæ ranging in thickness from one inch to two feet. This form of the rock is locally known as *firestone*, and is in repute for making jambs and hearths, where it will not be subjected to a very high temperature. It splits with wonderful evenness, and may be broken into almost any shape wanted, with the hammer. It outcrops on the farm of Ben. P. Chatham, southeast of Orleans, where the following section was made:

SECTION NO. 5, ON FARM OF B. P. CHATHAM.

Slope covered	16.00
Building stone, white and fine grained, No. 8	6.00
Lithographic limestone, No. 8 of connected sections	18.00
Chert, fossiliferous, No. 9 of connected sections	2.00
Firestone, thin bedded above, No. 10	10.00
Massive limestone, No. 10	12.00
Total	64.00

The firestones also outcrop on the road from Orleans to Orangeville just west of the crossing of Lost river below Alfred Bruner's farm, and on his farm, also near Orangeville and north of the sand hill near Orleans.

The cherts, No. 9 of the connected section, are the most conspicuous and widely distributed of the rocks of the St. Louis group. Having resisted the eroding action that has worn away the less resisting limestones, they are everywhere strewn over the surface of the ground, and buried in the red clays. Besides the regular beds under consideration vast quantities of smaller specimens are from the concretionary limestone. Lithologically they differ very much in hardness, fracture and color. Those found on the western and southern borders of the St. Louis limestones are characterized by a highly red color, derived from the infiltration and deposit of hydrous peroxide of iron, while those found in the northeast part and along Stamper's creek are stained a brown color by the brown oxide, giving them much the appearance of chalcedony. In hardness they are equally variable; those that are highly bryozoic are soft and easily broken or split, but usually breaking or crumbling into irregular fragments; those that are very hard break into square or wedge-shaped pieces. Exposures of these last may be seen on the Orleans and Paoli road. Aside from the valves of a spirifer seen sticking on the surface of stone they are not fossiliferous. Near Cave spring and on the lower dry bed of Lost river where the chert forms the surface rock and has not been disturbed by the forces that have removed the superincumbent limestone, we find it very hard and silicious, of a gray color and abounding in fossils. At these points it is a true *buhrstone*, and has been used as such in making a run of stone in the old Orangeville mill. The distribution of these rocks have been sufficiently indicated above. The bryozoans found in it are frequently most perfect and beautiful, and belong to some one or more species of *Polypora*, probably *P. gracilis* and *P. Hamiltonensis*. Specimens of a *Pinna* are found in it, measuring over five inches in length. No crinoids have been found,

though portions, ossicles, of stems are not infrequent, and one very pretty little star fish was picked up near Orleans. The cherts, when decomposed in consequence of the free admixture of iron, give rise to the red clays (paint). The chert may be seen in place on the farm of B. P. Chatham, at the rise of Stamper's creek, near the residence of George VanCleve, and at the Wesley Chapel gulf, where the following section was made:

SECTION NO. 6, AT WESLEY CHAPEL GULF.

Slope, with sandstone capping the hill, massive limestone, with shaly partings and thin beds of argillaceous stone	60.00
Chert, fossiliferous No. 9 of connected section	3.00
Concretionary limestone to low water No. 10	30.00
Total	93.00

CHESTER GROUP.

Within this group is embraced the remaining undescribed limestones and all the sandstones, except those capping the hills on the west and south part of the county, that form a part of the conglomerate or millstone grit epoch. The eastern boundary has been sufficiently defined in describing the St. Louis. It is difficult to give that on the west without a map. Suffice it, that a line starting on the north, five miles east of the northwest corner of the county and running south to French Lick springs, thence in curvilinear course to the south part of the county, west of Valeene, will be nearly correct.

Beginning at the base of the group we have first the lower Chester limestone, No. 8, which, in many respects, is a peculiar formation, especially as to thickness, when compared with the other strata, ranging from sixty to ninety feet, and in its greater uniformity of lithological characters and structure. Unlike the other limestones that are so variable, so far as we have seen, one section, with slight modification, might be made to answer for the whole county. Taken as a whole, it is a massive crystalline stone,

frequently lithographic, very evenly stratified, often with the heavier beds at the top.

A portion and sometimes the whole of this limestone has been referred to the St. Louis group. We think we have good and sufficient paleontological reason for putting it in the Chester. The fossils found in it, besides those enumerated in the connected section, are those that have heretofore been regarded as characteristic of the Chester group, and some of them, especially *Bellerophon carbonarius,* as confined to the coal measures. None of the fossils of the St. Louis limestone and cherts have been found in it, except those that are known to have a very great vertical range, as the *Spirifers* and *Producti, Lithostrotion Canadense* and *L. proliferum.* Fossils peculiar to the St. Louis group have been found in great quantities in and below the St. Louis chert, (No 9), but *never* above it. The absence of these two fossils alone, we take it, is sufficient reason for making the division where we do, between the Chester and St. Louis. In coming to these conclusions we are greatly indebted to Prof. E. T. Cox, State Geologist, to whom was submitted for examination, a tolerably complete suite of fossils, from this horizon.

SECTION NO. 7, SAND HILL NEAR ORLEANS.

Slope.	
Sandstone, base glass sand, No. 7 of connected section	22.00
Heavy bedded limestone, lithographic and crystalline quarry stone; fossils, *Phillipsia, Euomphalus planorbiformis, E.* (N. S.?), *Bellerophon carbonarius, Retzia vera, Pleurotomaria* (Sp.?), *Terebratula bovidens, Rhynchonella mutata,* and *Athyris subtilita,* No. 8 of connected section	35.00
Chester chert No. 8	1.00
Limestone in thin strata; fossils, *Athyris ambigua* and *Syringopora,* No. 8	54.00
St. Louis chert, No. 9	2.00
Limestone.	
Total	92.00

The top member of the above section is very heavy, some

of the strata measuring over three feet in thickness. Stone has been taken from the quarry here for several years, and has been re-opened recently and some very excellent stone taken out. It was from this quarry that the stone for the foundation of the depot at Orleans was obtained. The experiment of burning lime from the lower member is being made with fair prospect of success.

SECTION NO. 8, LOCUST HILL, STAMPER'S CREEK TOWNSHIP.

Coarse-grained, even-bedded sandstone, No. 5	47.00
Shales, with bands of ochre, No. 5	13.00
Compact, crystalline limestone; fossils, *Archimedes*, *Pentremites pyriformis*, *P. Gordoni* and *Producti*, 2 sp., No. 6	17.00
Blue shale with ochre, No. 7 of connected section	8.00
Lower Chester limestone, No. 8	60.00
Total	145.00

SECTION NO. 9, AT ACRE SINKHOLE, STAMPER'S CREEK.

Heavy bedded quarry sandstone No. 5	10.00
Compact, massive limestone; fossils, *Productus cora*, *P. semireticulatus*, *Spirifer lineatus*, *Archimedes* and *Pentremites*, No. 6	25.00
Coarse sandstone, partly covered, No. 7	70.00
Limestone, with nodules of flint; fossils, *Euomphalus* and *Terebratula bovidens*, No. 8	40.00
Chester chert	1.00
Heavy bed limestone to S. C. Church, No. 8	45.00
Total	191.00

The lower Chester limestone here is filled with black flint nodules identical with those of the equivalent stone of Lawrence county, and the chert of this section, though nearly white, is of the same character. In fact, all the Chester cherts, wherever seen by us, have very much the appearance of a true flint or hornstone and with propriety might be called flint rather than chert.

On the top of the hill at this point is a remarkable cavity known as the "acre sinkhole." In shape it is almost perfectly round, and about 60 feet deep, with very abrupt sides, quite different from similar basins in the St. Louis formation.

These well shaped openings are not uncommon in the Chester. They are readily distinguished from true sinkholes by the absence of the chert, their more regular outline, abrupt sides, and the want of any central subterranean opening.

The upper sandstone, No. 5, in this township, is a very evenly stratified stone, of buff color, that is readily quarried by a little stripping, in blocks of fair length, and in thickness ranging from one to three feet. It makes excellent foundations for light buildings, such as barns and other wooden structures. It works easily and will weather well. Quarries have been opened on the Locust hill, on the land of Mrs. Clements and on the land of Henry Polson.

SECTION NO. 10, ALBERT'S HILL, PAOLI.

Massive sandstone: fossils, leaves and stems of *Stigmaria*, No. 5, of connected section	30.00
Blue shales, No. 5	6.00
Crystalline limestone, with *Productus cora*, *P. semireticulatus*, *Pentremites pyriformis*, *Archimedes*, *Spirifer lineatus*, *Athyris subtilita* and stems of crinoids No. 6	16.00
Encrinital limestone, No. 6	14.00
Sandstone, No. 7	8.00
Decomposed limestone, local	12.00
Sandstone massive, No. 7	22.00
Crystalline massive limestone, No. 8	18.00
Lithographic limestone, No. 8	70.00
Total	196.00

The lower Chester sandstone, No. 7, which at many places is a shale of no value, is in the vicinity of Paoli an even-bedded rock, in some places of sufficient thickness to make a good quarry stone. East of town, Mr. Kibler has opened a quarry in which beds of stone measuring two and three feet thick are exposed. On the lands of Mr. J. C. Albert, section 25, township 2 north, range 1 west, is a quarry of a pretty tea-green stone, from which blocks of almost any required size can be taken. For flagging, these sandstones are very superior. Along the banks of Lick creek, the

lower Chester limestone has been found to be a good building stone. The rock used in the court house is from this horizon and demonstrates that when carefully selected it is a very excellent stone for foundations of heavy structures. It is probable that the lower strata will be found to contain less crystalline matter and fewer *glass* seams.

SECTION NO. 11, AT GASAWAY HILL.

Blue and red shales, No. 5	27.00
Sandstone flagging, No. 5	16.00
Limestone, with *Pentremites obesus*, *P. pyriformis*, *Poteriocrinus Bisselli?* *Producti* and *Agassizocrinus conicus*	30.00
Soft sandstone	1.06
Blue shale	1.06
Yellow ochre	.06
Coal	.04
Soft sandstone, No. 7	12.00
Lower Chester limestone	42.00
Chester chert	1.00
Total	121.10

The above section is given to show the place of a thin coal seam that outcrops here and in the hills on the east. It has no fireclay beneath it, one of the essentials of a true coal bed. It is not likely that any of these coals will ever pay for opening, as no workable beds have been found below the Chester limestone.

SECTION NO. 12, AT ORANGEVILLE.

Massive sandstone, stained with iron ore	45.00
Middle Chester limestone, No. 6	19.00
Shaly sandstone, No. 7	18.00
Ochre, with a trace of coal and iron ore	1.00
Lower Chester limestone, with *Terebratula bovidens* and *Rynchonella subcuneata* in lower members	95.00
St. Louis limestone to low water	30.00
Total	208.00

In the vicinity of Chambersburgh and Valeene and the southeastern part of the county, the Lower Chester is the prevailing limestone. It is exposed on the hill-sides and

in the valleys of Greenfield, Jackson, French Lick, Orangeville and Northwest townships, and is the only limestone of any economic value in these regions. Throughout the remainder of the county it retains the same characters that have been described as belonging to it, in the preceding pages.

At the farm of Mr. Kinley Osborn we were shown an argillaceous stone near the base of this stratum that seems to have hydraulic qualities. The bed is about eight feet thick and should be tested. An analysis could scarcely determine the quality of the cement it would make. Actual manufacture is the best method.

SECTION NO. 13, ON ROAD SOUTH OF FRENCH LICK.

Conglomerate sandstone, No. 3 of connected section...	45.00
Upper Chester limestone, with band of chert at the top; fossils, *Archimedes Wortheni*, *Athyris Royissii*, *A. subtilita*, *Pentremites robustus*, *P. pyriformis*, *Spirifer lineatus* and *Producti*..................	15.00
Coarse sandstone, No. 5..................................	35.00
Coarse grit, No. 5..................................	20.00
Massive sandstone, No. 5..................................	40.00
Blue shale, No. 5..................................	12.00
Middle Chester limestone, No. 6..................................	18.00
Sandstone and blue shales to Chester limestone.........	31.00
Total..................................	216.00

Here we have the upper Chester sandstone well developed, and showing an average thickness. In it is found the true grindstone grits, and valuable building stone. Commercially, next to the whetstone grit, it is the most valuable stratum of stone in the county. In its upper members it generally shows the characters of the coarse grit, but it is only locally of sufficient firmness to be manufactured. The principal quarries are, Thomas N. Braxton section 25, Jonathan Lane and H. Lashbrook section 26, Wm. Lashbrook section 24, and J. Bledsoe section 13, all in township 1 north, range 2 west. The stone is quarried in large blocks and cut with a saw into slabs of the required thickness; these, after marking, are broken into smaller pieces

and polished. The quarry of Mr. Braxton was formerly worked for grindstones, at present only "shoe rubbers" and scythe stones are made from it.

CONGLOMERATE OR MILLSTONE GRIT.

This epoch embraces the remaining territory not before noticed. It is principally confined to the north and west parts of the county. Where well developed, as in the north part, it is a mass of weather-worn rock, composed of quartzose pebbles, cemented together with coarse sand. In the central and southern part it looses its pudding stone appearance, and can only be distinguished from the other sandstones by its position above the upper Chester limestone. Locally it becomes a fine grained, compact grit stone:

SECTION NO. 14, TAKEN ON THE EAST SIDE OF THE HILL, AT THOS. N. BRAXTON'S WHETSTONE QUARRY.

Friable sandstone, No. 3	30.00
Coal, probably Coal A, fire clay not seen	1.00
Coarse sandstone, with *Stigmaria* leaves and iron ore near the base	50.00
Whetstone grit, with *Lepidodendra, Calamites, Stigmaria, Sphenopteris tridactylis, S. latifolia, Neuropteris,* and near the base *Paoli vetusta*, No. 3	21.00
Coal trace	.00
Coarse sandstone, locally glass sand, No. 3	40.00
Upper Chester limestone, with chert, partly covered	15.00
Sandstone and shales, No. 5	90.00
Middle Chester limestone, No. 6	20.00
Shales and sandstone	40.00
Lower Chester limestone, with a shaly parting near the top, to level of F. L. Spring	20.00
Total	337.00

The principal quarries that are worked in this vicinity are those of Thomas N. Braxton, section 5, township 1 north, sections 32 and 33, township 2 north; Wm. Able, section 32; George Reily, section 31; Lynch & Wolfington, section 29, and E. Pinnick, section 30, township 2 north; J. A. Moore, section 5, and S. Wolfington, section 4, township 1 north, all in range 2 west.

The ferns and other plants taken out of the lower members of fine grit are very fine. Specimens measuring two and three feet in length are not uncommon. We are indebted to Mr. John A. Bennett for a beautiful slab for the State collection.

SECTION AT DISHMAN'S QUARRY, SECTION 23, TOWNSHIP 3 NORTH, RANGE 2 WEST.

Conglomerated sandstone, with pebbles	45.00
Silicious iron ore	5.00
Massive sandstone, with *Stigmaria*	20.00
Shaly sandstone	4.00
Whetstone grit, with shaly partings; fossils, *Neuropteris*, *Sphenopteris*, *Hymenophyllites*, *Lepidodendra*, *Knorria*, *Cordaites*, *Calamites* and *Lepidostrobus*	20.00
Shale	.04
Coal	.10
Fire clay	.06
Massive sandstone, locally white glass sand, and coarse grit	38.00
Upper Chester limestone, partly covered, No. 4	3.00
Covered space and sandstone, No. 5	70.00
Middle Chester limestone, No. 6	12.00
Total	218.08

At the quarry of Julius Lewis, in the same section as the above, the coal is said to be two feet thick.

This coal, and the plants found in the grit above it, has sometimes been referred to the Chester group. On the authority of M. Lesquereux and Prof. E. T. Cox, to whom was submitted a suite of fossils from these beds, we refer it and all the sandstones above the upper Chester limestone of our general section to the millstone grit epoch, which is doubtless correct. This places the whetstone grit of Orange county in the same horizon as the "Ouachita oilstone" of Arkansas, that which seems to be only an altered sandstone, the result of chemical action to which the stone under consideration has not been subjected.

The fine grits are everywhere very evenly stratified and may be split with great ease. After splitting to the required thickness the stone is scratched on the surface

with a piece of soft iron and broken into whetstones. Two different colored stones are quarried, white and buff. The first is known as "Hindostan" and the second as "Orange" stone.

The fossils of these beds are generally casts remarkably well preserved, showing the finest markings with great distinctness. The *Lepidodendra* are remarkable for size. We have a piece that formed part of a tree that was uncovered for twelve feet that measured four feet eleven inches in diameter. Specimens of the leaves are found over twenty inches long. The fossiliferous beds are not worked as the stone will not split. The fossils are scattered through it in every direction and not bedded as in the shales and in the French Lick quarries. The thin shaly partings that come out in large plates are ripple-marked and covered with tracks of crustaceans or some other animals. The *dendrites* here found are remarkable for size and beauty, and for running through the substance of the solid stone.

LACUSTRAL OR ALLUVIUM.

The fine impalpable sands and clays of the lacustral epoch are developed in considerable force in Northeast and Stamper's Creek townships, in what is locally known as "flat woods." It varies in thickness from five to twenty-five feet and covers an area of about twenty square miles, overlying the St. Louis limestone. This lake influence is also seen in producing the damp, impervious soils of Patoka river and in the vicinity of French Lick. Wherever gum and persimmon trees are indigenous to the soil, the fine sands of this epoch may be found.

The alluvial is well developed along the creeks and rivers of the northern and central parts of the county. In the valley of Carter's creek and Lost river are evidences of a much greater flow of water at some period than takes place now. In some places where the valley is nearly a quarter of a mile wide the sub-soil is a mass of gravel that has been brought from some place on the east. In the bank of the

river below where the old Maxwell mill stood is a bed of this gravel more than ten feet thick. Doubtless these beds were formed at the close of the lacustral epoch.

LOST RIVER AND CAVES.

The waters of Carter's creek and Lost river increase in volume in their course across the outcrop of the St. Louis limestones until, after uniting and forming Lost river, it strikes the eastern exposure of the concretionary limestone in section 4, township 3 north, range 1 east, where is formed the first sink; the second is in section 8; the third in section 13, township 3 north, range 1 west, and the fourth in section 11.

During summer and in dry weather, the first sink takes in all the water, leaving the balance of the channel dry from this place to Orangeville. Light rains will cause this sink to overflow, and very heavy continuous rains for twenty-four hours will carry the water over the whole length of the dry bed. The dry bed or channel extends from the second sink to Orangeville, and is the means by which the excess of rainfall that can not find passage under ground is carried off, thus preventing an overflow of the surrounding country. The subterranean channel is not a simple, straight, cavernous opening through which the water rushes, but a complex system of mains and leads, a counterpart of the surface drainage. Nor do these underground channels follow the course of the dry bed as might be supposed from there being frequent openings along its banks that connect with them. In sections 33 and 34, township 3 north, range 1 west, are three openings that we may designate as wet weather rises. Whenever the water is running into the fourth sink in force, it bursts out at the rises, so that we have water running through both the upper and lower parts of the dry bed, and none in the middle channel.

The dry bed is not an open channel, and has not the vegetal and timber growth common to the margins of streams, but is studded with majestic forest trees, and presents a wild and picturesque appearance when filled with

the rushing waters after heavy rains, which seem to be lost in the depths of the forest.

The underground stream may be reached at the fourth sink, where the cavernous opening is something like eight feet wide and four feet high. The descent is gradual and 590 feet long. The river comes to the surface at Wesley Chapel gulf, in section 9, township 3 north, range 1 west, where the superincumbent rocks have fallen in and forced the stream to the surface. The subterranean stream may also be reached at this point through a cave in the side of the hill. Some years ago a boat was taken in and the channel explored for some distance to a fall, beyond which it was impossible to pass.

A few yards to the northwest, in the same section, is a dry cave of considerable size, that has quite a local reputation for its numerous large and beautiful *stalactites* and *stalagmites*.

North and near Orangeville is another gulf or rise, where the water runs on the surface for some few yards and again sinks.

Orangeville is usually spoken of as the "rise" of Lost river, yet it is thought, and doubtless correctly, that the true rise of Lost river is on the farm of Robert Higgins, a mile or more further down the stream. Rains on the head waters of Carter's creek and Lost river do not affect the rise at Orangeville, but rains on Fulton's branch, that sinks in section 16, township 3 north, range 1 west, do, so that the water at Orangeville is rendered muddy and increased in volume. Yet we must think that Fulton's branch alone is insufficient to account for the whole of this rise, and it is probably fed by other underground streams.

Stamper's creek, in a small way, is a counterpart of Lost river, lacking the dry bed. It is thought that it again rises at the Spring mills and forms the source of French Lick. Saw-dust and other refuse from saw-mills situated on the banks of the creek have been worked out at the Spring mills.

The animal life of the caves and subterranean streams is much the same as that of the Mammoth and Wyandotte caves. In them have been found blind fishes, *Amblyopsis, speleus*, *Potamacotlus Carolinensis*, seeing. Crawfishes: *Cambarus pellucidus*, blind, *C. Bartoni*, seeing; *Cæcidotea stygia*, *C. Packardii*, *Crangonyx vitreus*, *Euphilosia Elrodii*, and *Cauloxenus stygeus*, small crustaceans. Insects *Anthomyia?* *Anopthalmus tenuis*, *Platynus marginatus* *Cenothophilus Sloanii* and *C. subteranea*.

MINERAL SPRINGS.

French Lick and West Baden springs are situated on the west side of the valley of French Lick creek and break out through fissures in the lower Chester limestone. Springs are found scattered along the valley for about one mile. But as yet only those at French Lick and West Baden have been improved. Doubtless their origin is explained on the same principle that the waters of an artesian well become more or less impregnated with salts and gases dissolved by the water, in its passage, under pressure, through many different kinds of shale and stone.

The existence of these justly celebrated springs was early known, and are said to have been a place of resort held in high esteem by the aborigines.

They are pleasantly located in a picturesque region of hills, covered with their primitive forests of dense wild wood, affording a most delightful place of recreation during the heated term. At both places are excellent hotels, pleasantly situated on elevated grounds, well ventilated, with good rooms and supplied with every thing necessary to make guests and invalids comfortable. Attached to the hotels are the usual bowling alleys, croquet grounds, ball rooms, post offices, and in short everything found at a fashionable watering place. At present, French Lick is under the management of Dr. S. Ryan, and West Baden under that of Messrs. Noah Cook & Co.

For the information of those who may not have the Geological Survey of Indiana, 1870, in which are analyses

of these springs, by Prof. E. T. Cox, State Geologist, they are here repeated:

FRENCH LICK SPRINGS.

These springs break out in a multitude of places along the branch, each is claimed to possess special curative properties.

"A qualitative chemical examination at the fountain head, revealed that they all contained the same elementary constituents, but in varying proportions: Temperature of air, 92° F.; temperature of water, 56°. Numerous bubbles of sulphureted hydrogen and carbonic acid gas, mixed with oxygen and nitrogen gas, were continually escaping from the water. I succeeded in collecting a small quantity of this gas, which served for the analysis, the principal constituents being:

Free carbonic acid. Free sulphydric acid. Sulphuric acid. Carbonic acid. Hydrochloric acid. Soda. Potash. Lime. Magnesia.

Quantitative analysis of the water of the French Lick Springs, taken from "Pluto's Well," given in parts in 1,000,000 or pounds in 100,000 gallons in the first column, and in grains in an imperial gallon in the second column.

The gaseous contents in one imperial gallon are represented in cubic inches:

Carbonic acid	7.337
Sulphydric acid	6.717
Oxygen	5.407
Nitrogen	18.504
Total	38.045

Total solid matter in one gallon, 381.85 grains.

	Parts in 1,000,000, or pounds in 100,000 gallons.	Grains in one gallon.
Silicic acid	9.42	.6594
Oxide of iron	1.90	.1330
Lime	675.92	47.3144
Soda	1140.20	79.8140
Potash	41.72	2.9204
Magnesia	723.26	50.6282
Alumina	48.10	3.3670
Chlorine	1185.96	83.0172
Carbonic acid	690.55	48.3385
Sulphuric acid	845.55	59.1885
Iodides and Bromides	trace	trace
Total	5362.58	375.3806

The above constituents are probably combined as follows:

	Parts in 1,000,000, or pounds in 100,000 gallons	Grains in one gallons.
Silicic acid	9.42	.6594
Oxide of iron	1.90	.1330
Sulphate of lime	223.03	15.6121
Sulphate of soda	58.16	4.0712
Sulphate of potash	17.31	1.2117
Sulphate of magnesia	954.41	66.8087
Sulphate of alumina	85.46	5.9822
Carbonate of lime	574.00	40.1800
Carbonate of soda	68.52	4.7964
Carbonate of potash	47.48	3.3236
Carbonate of magnesia	753.00	52.7100
Chloride of calcium	470.04	32.9028
Chloride of sodium	2027.04	141.8928
Chloride of magnesia	72.81	5.0967
Iodides and Bromides	trace	trace
Total	5362.58	375.3806

WEST BADEN SPRINGS.

These springs are about one mile north of French Lick springs. Here, also, the sulphur water breaks up in a great many places. I made at the fountain head a qualitative analysis of the three that were most used and found

in all the same elementary constituents. Temperature of air, 93° F.; temperature of water 55°. A whitish slimy deposit is formed on the gum, mostly sulphur, with some oxide of iron:

Free gases. Sulphydric. Carbonic acid. Oxygen. Nitrogen. Sulphuric acid. Hydrochloric acid. Carbonic acid. Soda. Potash. Lime. Magnesia.

I could spare only the time to analyze one, and selected for the purpose the water from the spring with a stone curbing as it appeared to be the most frequented:

The gaseous contents in one imperial gallon are represented in cubic inches:

Carbonic acid	6.198
Sulphydric acid	5.931
Oxygen	2.093
Nitrogen	6.572
Total	20.794

The mineral constituents are given in parts in one million, or pounds in one hundred thousand gallons, in the first column, and grains in one imperial gallon in the second:

	Parts in 1,000,000, or, Pounds in 100,000 Gals.	Grains in one Gal.
Silicic acid	7.50	.5250
Oxide of iron	1.50	.1050
Lime	539.11	37.7377
Soda	765.26	53.5682
Potash	19.37	1.3559
Magnesia	610.76	42.7532
Alumina	43.50	3.0450
Chlorine	779.26	54.5482
Carbonic acid	675.21	47.2647
Sulphuric acid	601.30	42.0910
Iodides and bromides	trace.	trace.
Total	4042.77	282.9939

The above constituents are, probably, combined as follows:

	Parts in 1,000,000, or, Pounds in 100,000 Gals.	Grains in one Gal.
Silicic acid	7.50	.5250
Oxide of iron	1.50	.1050
Sulphate of lime	191.70	13.4190
Sulphate of soda	53.28	3.7296
Sulphate of potash	23.48	1.6436
Sulphate of magnesia	619.83	43.3881
Sulphate of alumina	77.28	5.4096
Carbonate of lime	709.43	49.6601
Carbonate of soda	19.08	1.3356
Carbonate of potash	10.71	.7497
Carbonate of magnesia	671.48	47.0036
Chloride of calcium	124.78	8.7346
Chloride of sodium	1337.18	93.6026
Chloride of magnesium	195.54	13.6878
Iodides and bromides	trace.	trace.
Total	4042.77	282.9939

OTHER SPRINGS.

On the west side of the valley of French Lick creek, between French Lick and West Baden, are three excellent sulphur water springs, owned by Mr. John C. Albert. Another spring breaks out in the bank of Lost river, on the farm of Nathan Lamden, and also a spring on the farm of Mr. Robert Higgins, about one mile south of Orangeville. None of these springs have been improved.

On the lands of Maj. D. S. Huffstetter, near Orleans, is a chalybeate spring of considerable local repute, that deserves a careful analysis.

As it takes many days to make a correct analysis of mineral water it was too late in the season when we commenced work to have any made for this report. And hence, we did not collect any water this year, as it should be as nearly fresh as possible at the time of making the analysis.

ECONOMIC GEOLOGY.

So little has been done in the way of prospecting for and opening the coal seams in the western part of the county

that but little can be told of their extent and value. Enough is known to justify us in saying, that two seams of coal are found in the county, the upper one of which is of some economic value; we refer to coal "A" of Prof. E. T. Cox, in his Indiana classification. This coal is found in all the higher hills along the western part of the county. The locality in which to make search for the coal is immediately above the heavy conglomerate sandstone overlying the whetstone grit. The outcrop of this coal is seen near the top of the hill on the land of Mr. Thos. N. Braxton, section 32, township 2 north, range 2 west.

So far as this coal has been examined, it seems to be a semi-block or dry coal, is too dry and burns too loosely to make a first class smithing coal. At the place named, and in all the higher hills to the west of French Lick, it would be advisable to search for and mine this coal for local use.

On the land of Mr. Charnes, section 8, township 1 north. range 2 west, and on the line of survey of the proposed Rockport & Mitchell railroad, near the south line of the county is found and has been mined, a sub-conglomerate coal which in these places is a true block coal, and thirty inches thick. This coal may be searched for about thirty to forty feet above the upper Chester limestone, and but a feet below the whetstone grit. Farther north, it thins out to such an extent as to be entirely worthless. Besides these two seams, which may in many parts pay for developement, there is another Chester coal in this county on which some labor and money has been spent but which can not in any place pay for mining, as it is only from one to four inches thick. It is located just above the lower Chester limestone, and is exposed at many places in the county, the most noticeable is on the land of Mr. Gasaway, one mile north of Paoli. In the central and eastern parts of the county is found a thin seam of cannel coal, in the St. Louis limestone, and it is our duty to advise that no money be expended in prospecting for it, as it can not possibly prove of any commercial value.

IRON ORES.

The hydrated brown oxide of iron, found in the conglomerate above the whetstone grit, is of great importance. It is found in all the hills in the western part of the county. In some localities it is comparatively free from silica. An analysis of selected specimens, obtained from section 8, township 1 north, range 2 west, have proven to be very rich, containing over fifty per cent. of metallic iron. This ore has been mined to a considerable extent in Lawrence county, and smelted at the blast furnace at Shoals, making, in combination with the Missouri ores, an excellent neutral iron. This ore is from three to ten feet in thickness, and will, when the proper facilities of transportation are completed, justify the erection of blast furnaces at many points along the western boundary of the county.

WHET-STONES AND GRIND-STONES.

One of the most important minerals of this county is the long celebrated Hindoston stone, or what is known as the whet-stone grit, being unsurpassed by any in the world as a water stone, even in texture and fine grained. From this stone is manufactured ax stones, carpenter stones and "slips." The principal manufacturers are Thos. N. Braxton, near French Lick, and Louis Chaillaux, who is manufacturing for Mr. F. E. Dishman, in the northwest corner of the county.

The geological horizon of these quarries is indicated in the general connected section of the county. The following local section is taken at Braxton's quarry, in section 5, township 1 north, range 2 west:

	Ft.	In.
Stigmaria sandstone	7	00
Hard sandstone with shaly partings	3	00
Shale	0	06
Whetstone grit	1	06
Shale	0	10
Whetstone grit	2	10
Shale	0	10
Workable whetstone grit	2	10

Shale	0	06
Whetstone grit	2	10
Total	23	

The stone is quarried and broken into proper form and size, and finished by steam power.

At Dishman's quarry we have the following section. It is located in section 23, township 3 north, range 2 west:

	Ft.	In.
Stigmaria sandstone	6	00
Shaly sandstone	4	00
Whetstone grit with shaly partings	20	00
Shale	0	04
Coal	0	10
Fire clay	0	06

At this quarry is also steam works, with a capacity to finish about six hundred boxes per year.

Besides these mentioned, there are several more quarries where the finishing it done by horse power.

The demand for these stones increases with facilities for manufacture, and large invoices are shipped to Sheffield, England.

The Hindostan grindstone grit of this county is justly celebrated. It is of uniform texture and keen bite; of sufficient solidity to adhere together under any rate of speed that may be necessary. Grindstone quarries have been worked in various parts of the county. The geological horizon of the grindstone grit is lower than the whetstone quarries, being in the Chester group, just above the middle Archimedes limestone.

The most extensive quarry of this stone is worked by Mr. Thos. N. Braxton, on section 25, township 1 north, range 1 west, from which he is manufacturing shoe rubbers and scythe stones. Owing to their freedom from glazing, there is no better stone for these uses. For the same reason, this stone would make an excellent grindstone to work dry. We indicate the position of this stone in the connected section in No. 5.

BUILDING STONE.

Good limestone and sandstone, suitable for building purposes, is found in great abundance in the county. One member of the lower Chester limestone, furnishes, in many parts of the county, a good, fine grained, and easily worked stone, which is white as alabaster. This is quarried at the sand hill near Orleans; is exposed on the road from Orleans to Paoli, two miles south of the former place, and found on the lands of Benjamin P. Chatham and James A. Frost, section 5, township 2 north, range 1 east.

As mentioned elsewhere in this report, the lower Chester sandstone is sometimes a good quarry stone. It is found to be so in the vicinity of Paoli, at the quarry worked by John C. Albert, on section 25, township 2 north, range 1 west. The stone is of a light, tea color, the upper members making a superior flagging stone, and the lower a good building stone; is easily quarried and readily worked.

LIME.

There are some members of the St. Louis limestone, in the eastern and central portions of the county, that make good lime, but the best of lime is made from the lower Chester. This was formerly worked extensively on Lost river, near West Baden, in French Lick township, and shipped to the southern market by flat boats. A kiln is now being erected on the hill northwest of Orleans, in which to burn this stone into lime.

CLAYS.

A fine lacustral clay abounds in the northeastern part of the county, which has been manufactured into stoneware of a very good quality, at Lancaster, on the L. N. A. & C. railroad. It could be worked to good advantage into roofing or drain tiles. We find *Kaolin* in the county, but as yet not in quantities to render it of any commercial value. Samples of good *Indianite* have been picked up on the land

of Mr. O. Burnett, section 20, township 3 north, range 1 west. A three feet stratum of a very fine yellow ochre is exposed on the land of Mr. Freeman, section 7, township 1 north, range 2 west.

AGRICULTURE.

The topographical features of this county are quite varied, being determined by the outcrops of the various geological formations within its limits, and we find a corresponding variety in the nature and fertility of the soils. As but few of the hills and ridges reach above the upper Chester limestone, all the essential elements necessary to produce a good soil, are well proportioned. The addition of calcareous matter, derived from the limestones, furnishes the necessary material to render the soil mellow and warm, and supply elements which give to the soils of this county more than average fertility and renders them quite superior to the arenaceous lands destitute of lime. The St. Louis limestones, Chester sands, and Lacustral clays are the principal divisions. The calcareous lands are all very fertile, with a subsoil of red clay resulting from the admixture of oxides of iron and associated minerals. In this respect they are very different from the white or colorless clays of the chert region of some of the other States. The Chester sands are, as a rule, warm and mellow, producing heavy growths of timber, corn and the other small grains. The Lacustral lands are heavy, alternating blue and black clays, largely intermixed with fine sand, rendering it close and rather cold for corn and wheat, without better drainage. Yet good crops are produced by planting on the top of the over-turned sod and shallow cultivation, so that the decaying sod may act as an underdrain. These soils are *par excellence* the grass lands of the county. On them timothy and red-top grow luxuriantly; clover does not do so well, freezing out in a year or two. Doubtless these heavy soils would be much improved by under-draining They are the same kind of clays as those of Jefferson county, mentioned

by Prof. W. W. Borden, in Geological Survey of Indiana, 1874, as so signally improved by drainage. We think the trial has only to be made to demonstrate its utility.

This county is well adapted to sheep raising, especially in the hilly portions that can not so well be planted with the cereals. All the streams and brooks of the valleys are bordered by bottom lands, which, if put in grass, would furnish an abundance of winter feed, while the hillsides will produce good pasturage for summer use. Water for stock is everywhere abundant. Especially do these remarks apply to the south part of the county. It is not better soil that is wanting, but better culture.

In traveling over the county, we noticed several considerable bodies of land that were badly washed. The remedy for this might be found in setting them with grass. From experiments made by Mr. J. C. Albert, on the hill east of Paoli, blue grass will succeed well on the soil derived from the Chester sandstones. To get a good and quick set, it should be sown on a virgin soil, and it is said that under proper management and pasturage, it will improve for thirty years.

Some of the finest fruit regions of the State are the chestnut hills of the central, and the sandstone ridges of the western and southern portions of the county. The experiments of Messrs. Fletcher Mavity, Wm. Martin, J. H. Lindsey and others demonstrate this fact. The warm, sandy soils are peculiarly adapted to the growth of peaches, very much improving them in flavor, size and color.

The abundant and luxuriant growth of the summer grape (*Vitis æstivalis*) on the hillsides and uplands, and an equally abundant growth of the winter or frost grape (*Vitis cordifolia*) on the low lands, together with occasional vines of the fox grape (*Vitis labrusca*) may be regarded as a certain indication of the adaptability of the soil to the cultivation of improved varieties of grapes. The Catawba and Isabella grapes have been grown with success, and doubtless the Concord, Delaware and other recent varieties will be found equally well adapted to the

soil and climate. The chert lands north and west of Orleans will be found excellent land on which to grow plums and other fruits that are liable to be attacked by the curculio.

TIMBER.

The varieties of timber found in the county being determined by the soils, may be divided into districts corresponding to the geological group into which the rocks are divided, each being characterized by some peculiarity, either of growth or species, yet having many trees in common that seem to be adapted to all the kinds of soil.

In the region of country underlaid by the St. Louis limestones, formerly there was a heavy growth of that monarch of our forests, the yellow poplar (*Liriodendron tulipifera*). Next in size and exceeding it in commercial value comes the black walnut (*Juglans nigra*). Before these two trees had been so much cut away, it was not uncommon to see logs of the former that measured five feet, and of the latter four feet in diameter. The following are common and of good size: white walnut (*Juglans cinerea*), sugar maple (*Acer saccharinum*), red maple (*A. rubrum*) buckeye (*Æsculus glabra*), hackberry (*Celtis occidentalis*), slippery or red elm (*Ulmus fulva*), American or white elm (*U. Americana*), nearly always called red elm here, shellbark hickory (*Carya olba*), mockernut (*C. tomentosa*), thick shell-bark hickory (*C. sulcata*), pig-nut (*C. glabra*), white oak (*Quercus alba*), red oak (*Q. rubra*) jack oak (*Q. imbricaria*), burr oak (*Q. macrocarpa*), black oak (*Q. nigra*), chinquapin oak (*Q. obtusaloba*) white ash (*Fraxinus Americana*) and wild cherry (*Prunus serotina*). Along the streams are a few sycamores (*Platanus occidentalis*), and water beech (*Carpinus Americana*). The undergrowth is remarkable for size, so that the woods present a very open appearance even in the wildest places. This growth is made up principally of dog-wood (*Cornus Florida*), red bud (*Cercis Canadensis*), crab apple (*Pyrus coronaria*), sassafras (*Sassafras officinale*). The shrubs are spice bush (*Lindera benzoin*), wahoo (*Euonymus atropurpureus*), and

paw-paw (*Asimina triloba.*) In the cherty and more rocky parts there is an increase of small timber and shrubs and the undergrowth very dense. Here we find the wild *Pyrus Americana*, hawthorns (*Cratægus coccinea*) (*C. tomentosa*), black haw (*Viburnum prunifolium*), and hazel (*Corylus Americana.*)

The timber found growing in the Chester sands includes yellow poplar, black and white walnut, the oaks, hickories, cherry and ash of those enumerated above, and in addition, beach (*Fagus ferruginea*), American aspen (*Populus tremuloides*. On the high ridges are fine specimens of chestnut (*Castanea vesca*), and in the open ground persimmon (*Diospyros virginiana*). In this region the growth is vigorous, and yellow poplars are very common. The warm sands seem well adapted to the growth of this tree, and dealers claim that the lumber made from it is superior to that from timber grown in the bottoms. The black oak, in bodies, is confined to the conglomerate formation, where the barrenness of the soil shows its influence, especially on the young hickories. Yet even here, the yellow poplars and white oaks grow to be giants, but not in so great numbers as in more favorable localities. In the lacustral clays we saw a few specimens of sweet gum (*Liquidambar styraciflua*). The beech is very peculiarly adapted to these heavy soils. In Stamper's Creek township, we saw whole groves in which the yellow poplar never grows. Among the rare trees we heard of a single cucumber tree (*Magnolia acuminata*), and saw a few winged elms (*Ulmus alata*).

ANTIQUITIES.

There are in Orange county many evidences of its having been at one time thickly populated by pre-historic man. Arrow heads, spear heads, axes and stone ornaments are found in considerable quantities throughout the county. Especially are these abundant in the vicinity of springs and streams. One mile east of Paoli, on the south bank of Lick creek, is the remains of the enclosures of a village, with many kitchen mounds within and surrounding it. The

enclosure proper is about twelve hundred feet in circumference, surrounded by a double earthwork. Within the enclosure are twelve mounds, from one to two and a half feet high, eight feet in length by about four in width, the longest diameter being from northeast to southwest. Without the walls are a number of similar mounds upon the margin of the stream. These mounds we judge to be only kitchen mounds, or the sites on which the wigwams of the inhabitants stood.

On the farm of Floyd McCoy, in Stamper's Creek township, are found a number of small burial mounds, built of a red clay which has been carried from the hills surrounding the bottom on which they are situated. On the land of Major D. S. Huffstetter, surrounding a chalybeate spring, are found numerous arrow heads, likewise at the rise of Stamper's creek.

GEOLOGICAL REPORT

ON

Vanderburg, Owen and Montgomery Counties

INDIANA.

BY JOHN COLLETT, M. A.

PROF. E. T. COX,

State Geologist:

SIR:—Herewith I hand you my reports on the Geology of Vanderburg, Owen and Montgomery, together with results of examinations of the coal fields in the southeastern part of Clay, and the coal measure rocks of Putnam counties.

With acknowledgments for courtesies, I am,

Yours, etc.,

JOHN COLLETT.

Newport, Vermillion county, Ind., 31st Dec., 1875.

VANDERBURG COUNTY.

Vanderburg is situated in the southwestern part of the State, being, except one, the extreme southwestern county. Evansville, the seat of justice, and the chief city, is one hundred and eighty miles distant from Indianapolis. It

is bounded on the west by Posey, north by Gibson, east by Warrick county, and on the south by the State of Kentucky at low water in the Ohio river, and contains an area of two hundred and forty square miles, or 153,600 acres. The southern boundary is the Ohio—the "*Belle riviere*" of the early French adventurers—the beautiful river of song and story. Always navigable, without interruption from drought or winter's ice at this point, it is the great artery of trade and economic life to the bordering region, and bears upon its bosom a fleet of steamers equaling in value and tonnage that of some internal seas. Belted by broad alluvial plains or high bluffs, from which interesting views full of picturesque beauty may be attained, the river and valley has been compared by tourists to that Mecca of travelers, the Rhine of Europe. The eastern and northeastern parts of the county have their water-shed by Bluegrass, Locust and Little creek, through Big Pigeon into the Ohio, and the northwestern parts are drained by Big creek and its branches into the Wabash.

The river bottoms which border the Ohio are from two to six miles wide. Composed of a light sandy loam, they are very fertile, and produce profitable crops of corn, wheat, potatoes, tobacco and meadow grass. The forests comprise black and white walnut, red, white and burr oak, red and white elm, white and black gum, cottonwood, hickory, maple, willow, sycamore, cypress, pecan, etc., with many shrubs and vines. At several points, and sometimes in large areas, the cypress, the catalpa, cane and other sub-tropical plants survive as relics of the warmer clime which signalized the long past Lacustral age.

That interesting parasite, the mistletoe, was noted as common on the timber of the valleys, modestly hiding in the foliage of its victim during the summer, but in winter waving its ever-green plumes as if in triumph over the decay and death of the latter. It selects the following trees for its food and life, in numbers according to the order of enumeration; black gum and red elm seeming to be best suited for its growth. On 1,000 trees,

the following table will exhibit about the proportion attacked by this parasite:

1.	Black gum	500
2.	Red elm	420
3.	Water birch	20
4.	Black walnut	15
5.	Honey locust	10
6.	Blue ash	10
7.	Soft maple	10
8.	Hackberry	5
9.	Yellow willow	5
10.	Shell-bark hickory	2
11.	Spanish oak	1
12.	White oak	1
13.	Wild cherry	1
	Total	1.000

The other creeks flowing across the county, from northeast to south and southwest, are of no great capacity—generally small brooks, and in summer droughts are sometimes nearly dry, yet they flow through valleys from one to three miles wide, and largely greater than the probable erosive or possible usitude of the present streams and existing watershed, and demanding more powerful agencies for their excavation, than those existing at this day. This point will be further considered under the head of Glacial drift. Their "bottoms" are level, flat, and characteristically argillaceous, or hard and compact, and demand underground drainage for successful and profitable growth of the cereals. They are better adapted to meadow grass, and good crops of hay, etc., are grown upon them. The timber indicates the nature of the soil, and comprises white, burr, water and jack oaks, gum, elm, maple and sycamore, etc., with beech, sugar tree, poplar and walnut on sandy loams. These "flat bottoms," with a soft or muddy bed in the streams and brooks, are almost universal in regions where the bluffs and table lands are composed of thin, fine, impalpable sands of the Lacustral age, and the streams contrast unfavorably with the brooks, dashing and flashing over their rocky or pebbly beds, a short distance to the north.

From the creek and river valleys we pass, sometimes by gentle ascents, along the tributaries, but often by abrupt bluffs, to the table lands. The latter, in the central and northern parts, attain an elevation of from 150 to 350 feet, and average a hight of 225 feet above low water in the Ohio river; and being formed, as a rule, from lacustral, fine sands or loam, the soil is compact, and to a degree impervious to air and moisture unless drained or well intermixed with vegetable matter. The flat areas are wet and predisposed to prairies or "openings," but the slightly uneven surfaces are clothed with a thick growth of timber. Of this, post-oak, persimmon and sweet gum are characteristic if not peculiar. White, red and spanish oaks, black gum, maple, white and black hickory are common. The rolling uplands, containing a generous admixture of red calcareous material, imparted by fluviatile action, is richer, and has a corresponding growth of sugar trees, poplars, black walnut and ash added to the former list. Both varieties of upland, when properly cultivated, produce fair to good crops of corn, wheat, oats and meadow grass. The hills and high ridges, by the modifying influence of their elevation, are exempt from the destroying effects of sudden changes of temperature, and admirably adapted to the growth of tender fruits and vines. Advantage has been taken of this situation by progressive farmers and gardeners, and the many extensive and profitable orchards and vineyards of this county are regarded sure sources of income by their prosperous owners. These areas, entirely elevated above the malaria of the valleys, are remarkably free from fevers attributed to that cause. Good cisterns for filtering and containing rain water for family use, would furnish an ample supply of purer water than can be obtained from wells or springs in this soil, and would probably, in a considerable degree, avert inflammatory diseases.

Dr. D. D. Owen describes this Lacustral loam as a silico-calcareous earth, of pale reddish gray or ashen flesh tint. Says that, when in part composed of decomposed material

of coal measure rocks, it gives rise to some of the best tobacco land. He gives the following analysis:

Combined moisture	1.35
Soluble organic matter	.30
Insoluble silicates	73.30
Carbonic acid	10.00
Lime	6.80
Magnesia	3.78
Alumina and per oxide of iron	2.80
Chlorine	.12
Loss and alkalies	1.55
	100.00

An analysis of water leached through this material is found to contain an excess of magnesia, and observation shows that it has a deleterious effect on the health of those who habitually employ it for domestic and drinking purposes. During the prevalence of cholera, Owen observes, that those who habitually used this kind of water were apt to be more frequently and seriously attacked. In such localities, at times of drought, erysipelas and typhoid fevers are liable to prevail. Magnesia and its metallic combinations, rendered deliquescent by exposure to atmosphere, are not acute poisons, perhaps, in the small quantity which exists, but long continued use produces a chronic irritation which may tend to incite disease. Hence the use of pure, filtered rain water is earnestly urged.

RECENT GEOLOGY.

Alluvium.

The "river bottoms" or alluvial flats bordering the creeks and rivers, are due to causes now in action, and are composed of fine and coarse sand, gravel and smooth stones torn from older deposits and rounded by rolling over the rough bed by water in motion; clay and much vegetable matter, leaves, sticks and trunks of trees are often found buried at great depths, even more than 100 feet below the bottom of the present streams, and at the same time fluviatile sandbars and gravel beds are found from 100 to 200 feet above

the high water line, indicating the extreme range of our rivers, and the time necessary to erode and remove or sort and modify such an immense amount of material. This deposit is always found above or thrown against the banks or excavated edges of the older deposits, and never beneath.

LACUSTRAL EPOCH.

The Loess or Lacustral beds succeed in age, and are represented by an ash gray or brownish buff loam, composed principally of a siliceous material in a finely powdered condition, with a small amount of clay, and rarely containing shells of tropical or sub-tropical animals. A list of some of the typical shells is given in our report on Sullivan county, 1870. From the black muddy sediment deposited in the deepest water and in pre-existing canyon-like valleys, have been found teeth and bones of the *Megalonyx, Castoroides* and American elephant, and some other large animals not yet determined. The great Post Glacial lake covered a large area of the interior of the continent, including southwestern Indiana and regions adjoining to the south and west, marking its extreme high water line at between 700 and 800 feet above the level of the ocean, thence gradually decreasing in size and level to mere ponds and lagoons not over 300 feet above tide-water. Facts heretofore observed seem to indicate that some relics of the flora and fauna of that age have survived in sheltered spots—in the last lagoons—to this day, as the cypress, persimmon, pecan, smooth honey locust, catalpa, thorny sumac and cane, with the paroquet, cotton-mouth and grass snake and red-mouthed salamander, which are all of tropic or subtropic life.

The Lacustral deposits consist of:

Redish yellow loam, sandy	5 to 15 ft.
Gray and buff silicious loam	10 to 50 ft.
Black quicksand—muck with much vegetable matter in pre-lacustral valleys and channels	0 to 50 ft.
	115 ft.

In the last deposit, or in a cherty gravel lying on it, have been found in this and adjoining counties the bones of monster tropic animals, often of South American type, as the *Megalonyx* and other great Sloths, the mammoth or *Elephas Americanus*, the great beaver *Casteroides Ohioensis*, etc., part of which are described by Leidy in a memoir of the extinct Sloth tribe of North America, in Smithsonian contributions.

The remains just referred to are few and fragmentary and have been regarded as rather indirect and circumstantial. It is therefore gratifying that the present year should give facts which may be relied on to determine the "*climate and time*" about the close of the Lacustral period. In sinking a coal shaft at Henderson, Kentucky, at a considerable depth, a bed of animal and vegetable remains was passed, including many mussel shells. During the past months, in sinking the Avondale shaft at Evansville, a similar bed containing an immense quantity of fresh water shells was passed through. A small lot of the mussels were secured and submitted to competent authorities,* who, on comparing them with authentic specimens from type localities in the extreme Southern States of the Union, separately and then jointly united in the following determination:

No. 1 is closely allied to, if not a typical specimen of *Unio chunii*, Lea, from Trinity river, Texas and sparsely northward.

No. 2 is between *Unio lincecumii*, Lea, of Trinity river, Texas, and *U. plicatus*, Lesueur, of Ohio valley.

No. 3 is a good specimen of *Unio asper*, Lea, of Alabama river, a species nearly allied, *Unio asperrimus*, Lea, of lower Wabash and Ohio rivers.

No. 4, *Unio obliquus*, Lamarck, common in Ohio river and near tributaries.

No. 5, *Unio purpuratus*, Lamarck, of Gulf State streams, occasionally found in Tennessee and Arkansas. A single specimen was taken by F. Stein, C. E., about two years ago in Ohio river near Mt. Vernon.

*Dr. G. M. Levette and Mr. John W. Byrkit.

No. 6, *Trypanostoma unciale*, Haldeman, Tennessee and sparsely in Ohio valley.

No. 7, *Trypanostoma canaliculatum*, Say, common in Wabash river.

No. 8, *Trypanostoma alveara*, Conrad, *var. torquatum*, Lea, of Alabama river.

No. 9, *Lioplax cyclostomatiformis*, Lea, *var. contorta*, Shutt. Alabama river.

No. 10, *Melantho ponderosa*, Say, common in Wabash river.

These shells, wholly extinct, or barely existing as survivors from our ancient sub-tropic climate, reveal in their story a hitherto unknown chapter of past events, indicating a change of climate nearly equivalent to 10° of latitude, and which, according to Mr. Hopkins' paper before the British Scientific Association, must have taken place within from 20,000 to 70,000 years.

That our climate is still becoming colder is shown by the fact that in "shell heaps" of the pre-historic races and on ancient river beaches, the following shells are not rare: *Unio foliatus*, Hild., once common in lower Wabash, is almost extinct, but common in Cumberland river at Nashville, *Unio varicosus*, Lea, once abundant in lower Wabash is now rare, *Margaritana confragosa*, Say, is sparingly taken in lower Wabash but common in Green river, Kentucky, and South.

GLACIAL PERIOD.

There was no true glacial drift seen in the county; no boulders, or even pebbles and stones, except those which showed by their smoothness and absence of the marks of the glacial mill, evidence of the rolling transportation of river currents. The absence of a deposit of such magnitude, in the northern half of the State, was marked and emphatic, and proved not only that the glacier did not extend so far south, but also that its terminal foot rested on land, and not a body of berg-bearing water, for, had it terminated at or in a body of water casting off icebergs, boulders of large size would have been scattered along the path of its water discharge.

In the absence of the ordinary drift, still the glacial age is not silent. A primary set of ancient valleys, from 100 o 150 feet above the river, having a course from north 18° to 24° west, traverse the county. These are not continuous now, but are often cut across or partially silted up by a second, more recent system of valleys, passing from northeast to south and southwest. Now, in either of these sets of valley thoroughfares, after a rain, may be seen in the ditches, fine white quartzose and black sand or *magnetite*, from the Laurentian rocks of Canada. The most obdurate material of the glacial drift is here ground to powder, but easily recognized by its specific gravity and magnetic quality, and seems unmistakably to point to the glacial period for the origin of these valleys, the first being called into existence at the beginning of that phenomenon, before the Wabash valley had been excavated by the great flood of ice water which subsequently passed that way. The secondaries probably date to the time when the ice water, which sought sluice-way during the summer months, by what is now known as White and Patoka valleys, after excavating the great basin of South Patoka, described in the geology of Pike county, flowed, at different points, over the ragged rocky rim of that basin, to the south and west, leaving Snake Knob and Dittany Hill in Warrick county, and Mt. McGregor, Kennedy Knob, etc., in Gibson county, as monumental trophies of its prowess and power.

During this period, each summer's sun would drive back the northern sea of ice, melting away its winter's growth, and send floods of ice water down the sharply inclined surface of the country to the south, the winter's advance often obstructing and filling up older channels, causing the waters to vary much in course and volume. This flood was magnified by the great precipitation of moisture incident to the cold, foggy, arctic climate that prevailed. To this flood is referred the excavation of Pigeon, Black creek and other valleys, so much wider than can possibly be attributed to the present streams and water-sheds. At this time

facts show that the northern lake regions were at an elevation of not less than 800 or 900 feet above the ocean greater than at present, plunging this flood of water with violence down the rapid southern incline. As a consequence, these ancient glacial sluice-ways are not only wider than necessary for the present streams, but as further attestation of their extent, it has been recently found by artesian bores that they were also deeper than now; thus the Wabash valley at Terre Haute and at Lafayette is found to have been excavated to a depth of sixty feet below the present bottom of that river. White river fifty-two feet, and Eel river and Walnut fork of same, respectively, ninety-five and one hundred and twenty-three feet. Dr. Newberry has reported a similar state of affairs as to the Ohio river at Louisville, and all the streams flowing into that river through the State of Ohio.*

On Dittany hill, in Warrick, near the northeast corner of the county, my attention was called to a remarkable excavation locally known as the "Buffalo wallow," and the "Mineral diggins." Dittany hill is an elevated ridge over a mile long from north northeast to south southwest, with two spurs nearly parallel extending to northwest. The top of the ridge and spurs is one rod to five or ten rods wide, nearly level and is capped with Merom sandstone persistently underlaid with the hard, clinky, double limestone, from six to ten feet thick, which marks the top of the coal measures. The hill and spurs is a grand land mark, towering up like peaks, from one hundred and fifty to two hundred feet above the valley plains surrounding in every direction, which have been denuded to that extent, leaving this monumental remnant to tell the story of its former greatness and present degradation. The excavation was often visited and mentioned with knowing emphasis by mineral diviners, to whom such a mystery was vantage ground. A strange sight it was. An excavation had been

*A concise statement of the circumstances attending the Glacial and Lacustral periods is given in my report on Lawrence and Gibson counties, Indiana Gelogical Report, 1873, and Brown county ib. 1874.

made, removing, for a space of three hundred feet, the top of one of the spurs to a depth of thirty feet. The cut was made clean and was fresh as if of recent date. A careful examination detected no evidence of the "storied" lead or silver, nor even iron, clay or coal. Nothing unnatural was visible which could incite the blindest of the unwary to dig. Natural causes were therefore sought, and it was soon noticed that the excavated matter was all "wasted" in one direction—to the south. In studying this debris it was found that the heavy cubes of sandstone and limestone had first been thrown or violently rolled to the side of the spur and the talus made up according to the specific gravity of the material, the lightest clay and shale being the farthest removed. It was evident that a violent current of water, flowing across the top of this hill before the surrounding valleys were formed, or afterwards, when the Lacustral waters covered the ridge, was the force which made the "diggins." A similar excavation is seen on the same spur less than half a mile to the west, while two complementary gaps opposite the two first mentioned, are found in the parallel spur to the north, showing that two currents of water swept across these spurs from the north 8° west, all washing the excavated material southward. Time did not admit of extended examination, but the facts observed indicate that this cut occurred after the glacial erosion had completed the denudation of the surrounding low lands, and rather at a time during the Lake period, when the Lacustral waters covered the top of the hill, and some sudden access of water in great volume, released from adjacent lake or lagoon, swept eroding currents across this sunken island in its bosom.

GENERAL GEOLOGY.

The rocky formations of this county consist of two members. The lower one, the regular coal measures, has been explored by outcrop, or shafts and bores, to a depth of about 1,000 feet, exhibiting the seams of coal, shale

sandstone, with thin limestones in much the same order mentioned in previous reports.

Covering the coal measures, in fact so allied as to seem to be their continuation, are two limestones, sometimes brought together, at others separated by small spaces, and generally accompanied by one or more rash coals, in which, although coal measure fossils predominate, a considerable number are found characteristically of Permian type. Some of these have never been found in the regular coal measures, as the broad-winged *Myalina* and *Meekella*, and allow the inference that these limestones may be synchronous with the so-called "Permo-carboniferous" formation, of Kansas and Nebraska, here thinned to less than sixty feet. Still above these carboniferous beds is a sandrock, to which the name of "*Merom sandstone*" is given, in report on Sullivan county, (Ind. Reports, 1870). In each of my succeeding reports, I have retained this stone in the carboniferous, although suggesting that reasons existed which allowed their reference to a higher position and later age. The facts which seem to allow this suggestion, will be briefly stated hereinafter, and although not conclusive, are given as a furtherance towards the goal which we all seek—the truth. These beds range in thickness from ten to seventy feet.

CONNECTED SECTION OF THE ROCKS, ETC., VANDERBURG COUNTY.

		Ft.		Ft.	In.
1.	Buff, brown, red and mottled slabs.	2	to	0	00
2.	Merom sandstone, soft, shaly, upper div.	20	to	25	00
3.	Merom sandstone, massive, in quarry bed.	10	to	30	00
4.	Dark gray or buff shales and flaggy sandstones with clay iron stone.........	10	to	20	00
3.	Brown Impure Coal, 3d rash coal	1¼	to	00	00
4.	Flaggy on thick-bedded sandstone, ripple-marked........	9	to	4	00
5.	Hard, clinky, gray limestone, at bottom irregular and sometimes flinty, passing to the west to a calcareous shale...	2	to	6	00
7.	Argillaceous shale and shaly sandstone.	34	to	0	00
7.	Black slate with fish spines and fossils...	1½	to	0	00

8.	SECOND RASH COAL	0	to	0	03
9.	Fire clay	1	to	0	00
10.	Gray shale	6	to	0	00
11.	Limestone, yellow ferruginous	3	to	12	00
11½.	Gray shale	98	to	0	00
12.	FIRST RASH COAL, and black slate	0	to	0	08
13.	Fire clay	1	to	2	06
14.	Soft, flaggy, blue, buff and gray sandstone, with much gray shale and beds of clay ironstone and nodules	60	to	121	00
15.	Yellow and gray sandstone, often giving good quarry beds	15	to	29	00
16.	Gray and buff alluvium, arenaceous or shaley, or flaggy sandstone, with ironstone nodules and shaly concretions	29	to	8	00
17.	Black slate or clod, with fossils			1	00
18.	COAL N, choice, gassy, caking			2	03
19.	Fire clay, at bottom shaly, with iron balls			5	08
20.	Buff or gray limestone with *Chætetes*	8	to	5	00
21.	Gray or white shale, with nodules of iron stone and bands of sandstone	30	to	40	00
22.	Siliceous shale, passing to massive sandrock to south and west; alluvial rock? of Lesquereux and Owen	60	to	71	00
23.	Black slate and clod, with many alluvial and vegetable fossils	2	to	1	08
24.	INGLESIDE COAL M: Laminated coal, 1 ft. 4 in.; parting, 2 in. to 0; solid cubic coal, 2 ft. 8 in.			4	00
25.	Fire clay			4	00
26.	Fire clay, with pyrite balls			3	08
27.	Siliceous shale			11	09
28.	Argillaceous sandstone			5	00
29.	Gray shale and soapstone			64	05
30.	Soapstone, with plant remains			0	03
31.	COAL L: Impure cannel coal, 1 ft. 6 in.; Pyritous argillite, 1 ft. 4 in.; slaty cannel, 1 ft. 2 in.; free burning coal, 1 ft. 3 in.			5	03
32.	Fire clay			2	06
	(Extra-limital.)				
34.	Siliceous shales and coarse massive ferrugenous sandstone	90	to	120	00
35.	Best limestone and black slate	2	to	8	00

36.	COAL K, caking, pyritous	0	to	1	06
37.	Laminated fire clay	2	to	1	04
38.	Siliceous and black aluminous shales, with rich bands and pockets of nodular iron ore	10	to	30	00
39.	Conglomerate sandrock	110	to	180	00
40.	COAL A	3	to	0	00
41.	Dark or black shale, with iron ore	30	to	5	00
42.	Chester sandstone and sub-carboniferous limestone.				
				837	08

MESOZOIC TIME.

Cretaceous beds exist in parts of Kentucky and Tennessee, and their mode of deposit authorized the expectation of meeting outliers in this county. No such beds were seen in place, although beds of plastic clay sometimes reported in deep wells, and generally referred to the decomposition of the hornstones of the sub-carboniferous limestones, may possibly result from the trituration of cretaceous material wholly eroded by the violent currents of glacial water; for such beds, friable and easily removed by such a sheet of water, is reported, by Prof. White, to have once existed over large areas in Iowa, but now entirely removed; a few characteristic fossils alone remaining to prove the existence of the mother rock. It can scarcely be doubted that relics of the cretaceous period may yet be found here.

TRIASSIC PERIOD?

At the horizon usually occupied by rocks of this period Safford reports an hiatus in Tennessee, all the intervening beds being absent, and more recent deposits are met in a line "along which the older formations are suddenly and deeply beveled off." If ever deposited, shaved off by aqueous currents. There is no positive evidence that such beds ever existed in this State, but a few facts will be briefly given which suggest the question as to whether the upper beds of sandstone and shale heretofore comprised in the coal measures may not possibly be referred to this period.

The sandstone and shales, Nos. 1 to 4 of the general section—the "*Merom sandstone*" of former reports—are the strata to which reference is made, and it is done for the purpose of turning investigation toward this point, rather than to ask attention to the few facts here mentioned.

This sandstone is well developed in Vanderburg and adjoining counties, capping the tops of the highest hills in the northeastern, and forming the surface rock in all the uneroded parts of the central and western regions. Judging from observations made in this county alone, it is regular in sequence, uninterruptedly covering the coal measures. But this bed extends for a considerable distance along the Wabash valley, and is well exhibited in Pike, Gibson and Sullivan counties, Indiana, and has been traced northward through several counties in Illinois. Although nearly continuous throughout this area, at several stations it is greatly thinned, sometimes, but rarely, passing into or covered with gray, blue, purple, pink and red shales. Always above the coals, it does not maintain such horizontality in reference to itself, as a deposit of such persistence should show. As to the coals, it is regular only in irregularity. Although always superior to all coals, at several stations it is deposited on escarped or eroded surfaces of the coal measures as low as seam M, the three higher seams with accompanying shales, slate and stone having been removed. It is therefore *unconformable* to the coal measure deposits, and this fact, when found, as in this case, to extend over wide areas, is generally considered an important point in fixing the demarkation between formations.

Next, the rock is unlike the regular sandstone of the coal measures. As a rule, soft, often so incoherent as to be easily cut with pick or shovel, and in such cases readily disintegrating into coarse, angular sand, yet it generally carries a "massive" or heavy bed, sometimes compact enough for coarse masonry. It is always ferriferous, and at many stations the iron is in irregular veins, rather than seams. Examples similar to the following description, extracted from report on Sullivan county, may be seen very

often in Knox, Gibson, Pike and Vanderburg counties. "The 'Merom sandstone' is here, at its northern terminus, well developed. Deep, narrow gorges, with precipitous or overhanging sides, give a romantic boldness to the scenery, and afford good exposures for observation. It may be characterized as a very coarse grained sandstone, varying in color from brown to yellowish red, with occasional strata of snowy whiteness, irregularly laminated."

False and diagonal bedding and coarseness of materials, show that it was deposited by strong currents of water, subject to frequent change of direction and to cross currents. Portions are compact quarry rock, which, however, on exposure, generally tend to disintegrate. The coloring matter is derived from small partings and veins of iron, which, being harder than their sandy matrix, fret the sides and over-hanging arches of the gorges with an irregular tracery of network in relief. To this may be added that fossils are rare or entirely absent, and confined, as far as my observation extends, to *Acrogens*, (*Calamites*). With this description may be compared the western higher sandstones, as given in last edition of Dana's Manuel of Geology, page 404. Again, the surest demarkation between formations, is the occurrence of siliceous beds, especially carrying a conglomeratic or pudding stone character. Such beds do not often occur in a regular formation, but are known to indicate a vigorous change of conditions, as exemplified, not only by stratigraphic novelties, but as well by partial disappearance of the older flora and fauna, and the introduction, in some degree, of new ones. At the base of this sandrock, we have heretofore had frequent occasion to mention a conglomerate or pudding stone underlying the Merom sandstone, in Gibson, Knox and Sullivan counties; the pebbles partly from coal measure rocks, and fossils in part from the older sub-carboniferous Devonian and Silurian formations. But especially significant, with these are found rounded pellets or pebbles of coal, in which the square or rhomboidal crystals are rounded by attrition, and seeming to indicate that they are fragments eroded by

currents, subsequent in age to their deposit, placed here by fluviatile and wave action. The same facts are noted in Edgar and Vermillion counties, Illinois, where the conglomerate beds are well developed and remarkable. In Illinois Geological Report, IV, pages 247, 248, a bed of this stone is described, and its irregularity properly attributed to "the heavy erosion which the beds, (coal measures), in that region evidently suffered, before the deposition of the sandstone." This erosion is found exhibited at that place on a grand scale, and the author cited "observed that a portion of the upper coal measures including shales, argillaceous limestones, and two coal beds, were carried away to a depth of sixty feet, and in the depression thus made, a sandstone, ('Merom sandstone'), which belongs at the top of the series, was laid down so as to fill and overlie it." The same authority, page 249, mentions the accompanying conglomerate, which has since been traced sporadically, for 150 miles to the southeast, and looking at it from a coal-measure standpoint, remarks, as others have done before and since in that line of vision, "that he is unable to conceive of any circumstances which could have produced just such a bed of rock."

Adjoining this locality, section 25, township 19, range 13, Vermillion county, Ills., Dr. J. C. Winslow, of Danville, Ills., discovered a bed of fossils which is named in his honor "Winslow's Bluff." They occur in a bed of black, brown, gray, red and pink shales, backed with sandstone, filling a depression denuded by forces acting at the close of the coal age, which has carried away the regular deposits, including probably three seams of coal. They consisted of separate vertebræ, teeth and other elements of several skeletons, amounting to about 93 bones and fragments, and were submitted by the writer to that distinguished comparative anatomist, Prof. E. D. Cope. After a careful study, Prof. Cope found that they comprised two new genera and species of Reptilia, and two of fishes. In a paper read by him and published in proceedings of Academy of Natural Sciences of Philadelphia, September 28 1875,

page 404, the Professor says that "A remarkable peculiarity of the vertebræ of the series is the longitudinal axial perforation of the centrum. They present the character observed in *Archegosaurus* and other *Stegocephalus* Batrachia; but which also exists, according to Gunther, in the living *Rhynchocephalous* lizard—the *Sphenodon* of New Zealand. The bones of the limbs and scapular arches are so decidedly reptilian, and so unlike those of any Batrachia with which we are yet acquainted, that I am disposed to refer them to the former class. And as there are several points in which the fossils resemble the order *Rhynchocephalia*, I refer them provisionally to that neighborhood. *They constitute the first definite indication of the existence of animals of that type in the Western hemisphere.* Associated with these Saurians were found teeth of two species of fishes, which are important in evidence of the position of the beds in which they occur. One of these is a new species of *Ceratodus*, Agass., and the other a *Diplodus*. The former genus is characteristic of the Triassic period in Europe, one species having been found in the Oolite. It still lives in North Australia. In both these respects the *Rhynchocephalian* lizards present a remarkable coincidence. *They also belong to the horizon of the Trias in Europe*, and the only living species is found in New Zealand. Thus it would seem that a fragment of this fauna, so ancient in the Northern hemisphere, and so remarkably preserved in the Southern, has been brought to light in (the Wabash valley of) Illinois" He names the new *Reptilia*, *Cricodus heterolitus*, and *Clepsydrops Collettii*, the fishes *Ceratodus basilatus* and *Diplodus Vinslovii*, and adds that while the first are so *distinctly of Triassic* type, that the last has not before been found above the carboniferous, and waits further material before venturing a decision whether they belong to *Triassic* or *Permian* time.

The foregoing facts are given without recapitalation. They strongly hint, although still meagre, at a solution of the *query* as to age and time with which this subject is headed, and it may be hoped that they will stimulate

research, which alone can definitely answer the question, *Criassic* or *Carboniferous*?

PALEOZOIC AGE.

Carboniferous Period.

The beds Nos. 3 to 14 of the general section, including two or three thin seams of rash coal, and two strata of limestone, each from two to eight feet thick, occupy the hill-tops in the northeastern parts, and thence dipping to the southwest, are found at or near the level of the streams in that part of the county. These beds are a notable horizon. Besides the advantage of the stone, which is burned for the lime, they form an unmistakable directrix from which to measure down to the probable level of the lower workable coals. The limestones Nos. 5 and 11, at their northeastern outcrop, are hard and clinky, and are frequently brought close together or found in contact. Going westward, they first become more plainly calcareous, are separated by a parting which widens at some points to a space of nearly fifty feet, and allows the introduction of a rash coal, becoming persistent to the west, but only represented by fire clays in the eastern parts. Persistent in the eastern parts, they become somewhat inconstant in the western, and pass into calcareous shales. In all adjoining regions, these limestones contain a multitude of fossils in great variety, which have given rise to bitter personal quarrels and disputes between eminent scientists. Some of these fossils, as *Meekella*, *Syntrielasma*, a *Myalina*, *Bellerophon crassus*, *Pleurotomaria turbiniformis*,* etc., are closely allied to Permian forms of Europe. These fossils, with many others are not found, in my knowledge, below the upper coal measures included by the numbers (5 to 14) under consideration. So many new fossils from this horizon have been described as of "the coal measures," that deciding from such determination, the rocks, notwithstanding the introduction, in part, of a new fauna, are coal measures. As a

*These fossils have not been found west of the Wabash river, but are abundant in equivalent beds in Illinois, adjoining to the west.

compromise, equivalent beds in Kansas and Nebraska have been termed by eminent geologists "*Permo carboniferous*," a designation which seems properly applied.

In this county these limestones, although often crowded or almost wholly composed of fossils, as *Athyris*, *Spirifer lineatus*, and *Lophophyllum proliferum*, do not offer good cabinet specimens. The coals, Nos. 3, 8, 12, are generally absent and never persistent over considerable areas. Impure and thin, they are consequently of no great economic importance. The thin fire clays, Nos. 9, 13, are of even more value, for generally unctuous and plastic, they afford as a rule a clay which, purified by exposure to atmospheric agencies, will work well for crocks, coarse pottery and terra-cotta ware.

No. 14, a soft, flaggy, blue, buff and gray sandstone, interchanging with gray shale, carrying iron stones, is found in the upper part of Ingleside shaft, in the bed and bluffs of Pigeon creek, and thence northeast of Evansville in the hills and banks of all the brooks and creeks. At several stations on Pigeon, a local stratum is quarried for rough masonry. Such beds are not persistent, soon passing into shale with wedge-shaped terminals.

The yellow and gray sandstone, No. 15, is found well down in the Evansville shafts, and is exposed only in the east and southeastern parts of the county. It has been quarried to some extent in the vicinity of Newburg, in Warrick county, and is well exposed in all the hills from five to seven miles northeast of Evansville. An extensive bed has been opened on the land of S. Stevens, northwest quarter of section 7, township 6, range 9, affording stone of excellent quality, which deserves the attention of builders, for foundations and hammered masonry. Blocks of good size may be obtained, and it is easily dressed when fresh from the quarry. Between this stone and the first workable coal, N, occurs gray and buff shales, passing into flaggy sandstones, carrying at several stations, nodules and thin shelly concretions of ironstone, but of no economic importance.

The black shale or clod, No. 17, is pretty constant, and differs from the slate usually found covering coals by the predominance of aluminous matter, rendering it soft. It usually carries a considerable number of fossils, most of which are pyritized, as *Productus cora, P. costatus, Athyris subtilita, Macrocheilus*, several species, *Bellerophon*, two species, etc., etc.

Coal N, No. 19 of the general section, is a choice gassy coal, of excellent quality; for analysis, I refer to the chemist's report of Millersburg coal as a type specimen. From appearances it is believed that this is equal to the best western coal for gas and coking, and although the seam will average but little over two feet, yet the purity and richness in volatile matter will justify removing the fire clay for potteries, and thus secure this valuable coal. It is passed in the Ingleside shaft, and was formerly worked by a shaft not now in use, on Steven's land, northwest quarter section 7, township 6, range 9. This coal will be found near the surface or in the hills in the southeastern parts, as it is just caught in the top of the bluff at Newburg, passes near the surface at Chandler's shaft, and below the the water level a short distance north of Millersburg. It is also pierced by Priest's bore at West Franklin in the extreme southwest corner of the county, and by the Kentucky shafts at Henderson—in fact at every point at which this horizon has been explored. These facts indicate a uniform persistence throughout this region of Coal N, a seam that is characteristically inconstant and unreliable in all the basin to the north and east. It is locally known as the "Little Newburg coal." Below the fire clay of N is found a buff or gray limestone, No. 20. This is not exposed in the county, but is met in all the shafts in regular position, and outcrops at Newburg, and thence north along the county line in Warrick county. It contains a few specimens of *Productus* and *Spirifer*, but is remarkable for the wonderful size of *Lophophyllum proliferum*, (some of the cups were seen from three-fourths to one and one-fourth inches in

diameter,) and a great profusion of the coral *Chætetes milleporaceus.* Next succeeds a gray or white shale carrying bands and nodules of iron ore of good quality, but not in sufficient quantity to be of any great value.

The siliceous shale and sandstone passing into massive sand rock along Green river and generally to the north and west, is a marked horizon at stations where exposed, forming quarry beds of economic importance, and bold river bluffs. In this county it is entirely below the surface and is seen only in shafts.

The black, slaty clod, No. 23, is generally persistent throughout this region, and carries a large number of beautiful and well preserved fossils. Generally pyritized, they form desirable cabinet specimens, viz: *Productus cora*, *P. longispinus*, *P. punctatus*, *Bellerophon carbonarius*, *B. Montfortianus*, *B. percarinatus*, *Macrocheilus inabilis*, *M. fusiformis*, *M.* (sp?) *Pleurotomaria carbonarius*, *P. sphærulata*, *P. Grayvillensis*, *Orthoceras Rushensis*, *Nautilus decoratus*, *Aviculopecten rectilateraria*, *A.* (sp?) *Leda bellastriata*, *Nucula inflata*, with crinoid stems. These are only a partial list of its marine life. Comb-like spines of fishes and dermal plates, named *Petrodus occidentalis*, are not uncommon; white bones and coprolites are frequent though crushed and fragmentary.

The Ingleside coal M, locally known as "Main Newburg" No. 24 of the general section, is the chief mineral resource of this region. This seam has been pierced, by shaft or bore, at a great many different points in this county and in regions immediately adjoining. At every station, with the single exception of the "Crescent City Park" bore, it has shown a thickness of not less than four feet. It is a strong coking coal, burns to a gray or red ash, and is an excellent fuel for steam or grate use, and commands, as it deserves, a ready market. It drives the wheels of commerce, pulls mighty railway trains, and gives energy to the thousand arms and fingers of iron which manufacture, with the strength of a million giants, the wealth of this favored city and county. From absence

of faults or barren places indicated by bores conducted up to this time, we may infer that it underruns southern and eastern parts, at least two-thirds of the area of the county, with a possibility if not a probability that it may be found in the remainder. A coal of such continuity is unusual, not often met in our coal field, and combining so many good with but few bad qualities, it may be looked upon as a grand source of wealth for ages, and assures for this region an enviable prosperity and progress for the future.

This coal has long been worked at Ingleside shaft, in Evansville, and at Newburg, Henderson and Green river of Kentucky. A new shaft has been put down at Chandler station, on the Boonville road; all of which find the seam regular in thickness, and differing but little in quality, as may be seen in the chemist's report of analysis. Another shaft is in progress at Avondale. These mines are more fully reported in local details. It is believed that in the near future, this grand body of coal will be more extensively mined; that far-seeing capitalists will erect the necessary machinery for crushing and washing, to remove the small amount of sulphur contained, and by coking in "Belgian furnaces," furnish a coke which is so much needed for smelting iron and the precious metals, in the west. The usual fire clay, below coal M, Nos. 25 and 26, in its upper member, is plastic, and in the future demand for fire-proof buildings, will be extensively used in terra cotta. Usually, it will be necessary to remove the diffused particles of pyrites by aeration. Strata of limestone are not reported in the sections to which access was had above N and immediately above M, as was found to be the case in Gibson county, but in the new shaft at Henderson, and in the bore at Ingleside, beds are found confirming the unexpected phenomenon of massive limestones in the coal measures, so unwillingly admitted in my report on Gibson and Knox counties. The space represented by Nos. 27, 28 and 29, has been pierced only by the lower shaft, in Ingleside mine. It is highly argillaceous, hardly rising above

the grade of clay shale; even the tough blue sandstone readily yields to air and moisture. This was to be expected, as similar material, in eight cases out of ten, characterize the horizon between coals M and L, in the counties I have visited in Indiana. Similar outcrops were seen at the same horizon, along Green river, especially at and near Cromwell Landing. A thin bed of soapstone, (indurated clay), is ordinarily found, succeeding which is rich in leaves and stems of carboniferous plants, and is known as the "fern bed." Sometimes the soapstone is replaced by gray shale, full of kidney iron stones, enclosing plants and fruits.

Coal L, No. 31 of section, offers the characteristic physical form and qualities usually presented throughout the Indiana coal field. It is a laminated semi-caking or free burning coal, rich in carbon, and yielding a gray or white ash, with little or no cinder. It is the most persistent coal of the Wabash basin in thickness, regularity and good qualities. In this vicinity it has been pierced by three bores, showing an average thickness of only about two feet, which may be regarded as the probable thickness of the seam along the southern and western part of the county. This will hardly justify mining at present. The seam, from indications in Pike and Gibson, will be found well developed in the northeastern half of the county, and, when facilities for transportation promised by proposed railways exist, will add materially to the available wealth. It is admirably suited for rolling mill, locomotive and stove use. Below coal L a hard ferruginous, laminated sandstone, passing into siliceous shales, has been pierced by bores, and occurs at adjoining regions in outcrops, filling a space of from 90 to 120 feet, at the base of which the limestone superimposing coal K is found; sometimes flinty, but on the Kentucky side of the river carrying the usual fossils as *Productus costatus, P. longispinus, Lophophyllum proliferum, Spirifer cameratus, S. lineatus, Athyris subtilita, Chonetes mesoloba, C. sp.?*, and *Crinoid* stems.

Coal K is not seen in the county. In bores along the Ohio river it never develops a thickness of two feet and

is generally thinner or barren. Typically it is a strong caking coal, containing some sulphur, and burns to red or brown ash. K is magnificently exhibited in the adjoining parts of Pike county, and we may reasonably expect that it underruns, with workable thickness, about one-third of the northeastern part of the county, gradually, but regularly, thinning and scattering toward and at the deep centre of the coal basin to the west. A short distance below the horizon of K, beds of black shale occur, which are often in bores, reported as coal. No thick or workable seams may be expected at this depth. The space usually presenting the block coals is here barren, as it is generally in the southern part of the State. It seems probable that at the central extreme depths of the basin the vegetable material, which if preserved pure would suffice for a coal seam, was largely intermixed with clay and argillaceous matter, and thus diffused and scattered, is represented by a black shale, and the ironstone, No. 38. The conglomerate sandrock, No. 39, forms the bottom rock or bed of the Coal measures. It is a course, red sandstone, heavy bedded or massive, containing, often, a few red and white quartz pebbles, conglomerated, but the latter are generally absent in the Indiana coal field. This sandrock is only pierced by the Crescent City Park bore in this county, and in neighboring wells, but is typically exhibited in adjoining regions to the northeast and south.

The sub-conglomerate coal A, is only known by report. It's existence in this region is, to say the least, problematical, and certainly of no economic importance. The deepest bores report beds of limestone and sandstone, which are referred to the Chester beds of the subcarboniferous period. These bores were put down during the oil excitement, and are not very reliable for minor details, but their steady concurrence, as to the underlying limestone, is regarded reliable. The foregoing gives a connected view of the surface phenomenon and rocky structure of the county. Details will be added for local information.

LOCAL DETAILS.

Near Evansville the surface rocks are the soft blue, buff and gray sandstones passing into argillaceous shales, No. 14 of general section. In this bed the "Ingleside" shaft in the west suburb of Evansville was begun, piercing in its depth the lower rash coal and shales, and N, M and L in succession. Thanks are returned to Mr. John Ingle for the following items:

SECTION IN INGLESIDE SHAFT.

(FORMERLY BODIAM.)

Fractional Section 26, Township 16, Range 11.

		Ft.	In.
1.	Clay and alluvial sand	29	00
2.	Clay and shale	61	00
3.	Slaty coal and fire-clay	3	00
4.	Sandrock	4	06
5.	Siliceous clay shales	12	09
6.	Shale and iron stones	5	08
	Fire-clay		10
7.	Ferriferous sandstone	7	09
8.	Fire-clay with sand and iron	12	03
9.	Sandstone (ferriferous)	12	01
10.	Shale	1	00
11.	Sandstone	7	05
12.	Coal N ("Little Newburg")	2	11
13.	Fire-clay with iron balls	5	08
14.	Limestone	5	00
15.	Fire-clay parting	2	06
16.	Limestone	4	06
17.	Gray shale black at bottom	83	10
18.	Coal M., "Main Newburg"	4	02
19.	Fire-clay	4	00
20.	Fire-clay with pyrite	3	08
21.	Siliceous shale	11	09
22.	Agrillaceous sandstone	5	00
23.	Gray shale (Soapstone)	64	05
24.	Soapstone (fern bed)		03
25.	COAL L: Impure cannel, 1 ft. 6 in.; pyritous argillite, 1 ft. 4 in.; slaty cannel, 1 ft. 2 in.; semi-coking coal, 1 ft. 3 in	5	03
26.	Fire-clay	2	06
		362	08

The foregoing is the pioneer exploration of this vicinity and corresponds generally with out-crops seen nearer the margin of the basin, excepting only, the unusual depression of the rash coal (No. 3 from top). In fact, in sections previously published and those which have heretofore came to my view, the occurrence of this coal at so low a level is not noted. The "Ingleside Mining Co.," John Ingle & Co., proprietors, have an establishment which, for intelligent direction and sufficiency of equipments, is rarely excelled. The shaft is arranged for double cages, ascending and descending at the same time, with third compartment for "air," thus securing good ventilation. The fixtures are driven by a steam engine of 90 horse power. The screens and dumps are ample and well arranged, with facilities for delivering coal on rail, river, or wagon for city use. These fixtures have an output capacity of 2,400,000 bushels per annum, or 200,000 per month. Largest output for one month, October 1875, was 91,000 bushels of lump; the least output was in June, 24,000 bushels.

Total output for 1875:

Lump coal..	720,000 bushels.
Nut and screenings..............................	80,000 bushels.
	800,000 bushels.

Making an average of 66,600 bushels per month.

Average price 6½ cents per bushel aboard car or boat.

Their principal market is for mills, factories and house use in the city, and for steamers on the Ohio river. Considerable shipments are also made by the Evansville & Chicago, and St. Louis & Southeastern railways. The mine, although situated immediately on the bank of the Ohio and to a small extent driven to the edge of it, is almost entirely free from water. There is none in the "workings," and the surface seep is hoisted in a half hour run, daily. In the black shale which forms the roof, are some fine fossils, including *Productus*, three species, *Bellerophon*, two species, *Aviculopecten*, two species, *Pleurotomaria*, two species, *Macrocheilus*, two species, and

a *Goniatite*, which I saw in the cabinet of Dr. Stinson. In the gray argillite a few feet above this coal, in the Henderson shaft, (Ky.), one of the proprietors obtained a *Conularia*, closely allied or identical with the one found in the subcarboniferous beds. The coal in the mine and accompanying rocks are as follows:

INGLESIDE MINE.

Argillaceous limestone, pyritous....		1 ft. 4 in.
Black slate (shale)........................		1 ft. 4 in.
Laminated coal	1 ft. 3 in.	
Parting	2 in.	
Solid caking coal	2 ft. 11 in.	4 ft. 2 in.
		6 ft. 10 in.

This coal ranges from three feet eight inches to four feet four inches, and averages nearly four feet at this mine, as, also, at Newburg, Henderson, Green river, etc. As before hinted, it is remarkably uniform in thickness and persistence; in fact, the single bore at the Crescent City artesian springs is the only exception, so far developed. In other regions of our basin, the coals are not so regular. Large barren areas intervene, or the seams narrow and are unworkable. One uninterrupted seam is equal in avails to several unreliable coals, and gives more certain returns. We may, therefore, feel confident that this single seam will assure great prosperity to this region, for the quality is good and the supply, practically, unlimited.

When coals become scarce, as in England, the upper two feet seam, (N), may and will be worked. Within Ingleside mine, a test bore was put down, under directions of Mr. William Adams, to whom I am indebted for the section. At the bottom, it was supposed from the borings that a five foot coal existed. A shaft was sunk, which developed the fact that part of the seam was impure or slaty, with only fifteen inches of good coal—not sufficent to justify working. The quality was good, as may be seen from analysis of coal L, in chemist's report. The specimen was obtained from Mr. Ingle. The dip of lower coals, L, M and N, from

Newburg via Evansville, along the center of the trough which gives direction to the lower Ohio valley, is eighteen feet nine inches per mile, with many irregularities or rolls. Dip to south, from the northern line of the county, is about twenty feet per mile, decreasing to eight or ten feet, until it passes the central synclinal, where the dip is reversed, ascending to the south.

A short distance east of the Ingleside mine, is the location of the proposed railway bridge, as a link in the nation's commerce, so necessary to the prosperity of Indiana and Kentucky. Test bores were put down under direction of Mr. W. Adams, who kindly furnished the following exhibit, which proves that good stony foundations are at hand, thus reducing the cost nearly one-half, as compared with the St. Louis bridge, etc.:

SECTION AT INTER-STATE R. R. BRIDGE.

(INDIANA SHORE).

	Ft.	In.
Clay	8	00
Sand	44	00
Blue clay	1	00
Marl, (shell bed?)	7	06
Shale	14	06
Total	75	06

(KENTUCKY SHORE).

	Ft.	In.
Sand and loam	67	06
Carbonaceous matter		06
Marl, (shells?)	7	06
Shale	15	00
Total	90	06

The "Crescent City Park" and pleasure grounds are situated on the east bank of Pigeon creek, southeast quarter of section 24, township 6, range 11. The grounds are well arranged, beautifully ornamented, and easily accessible by street railway. Hon. Wm. Heilman is proprietor. One of the most interesting attractions is a flowing artesian well, which furnishes a saline, sulphurous water of well attested medical properties. The bore, four and a quarter inches in

diameter, was commenced December, 1868, for oil.. In the upper part, a strong flow of burning gas, (carbureted hydrogen), escaped. This was continued until salt water was struck, at less than three hundred feet, which overpowered and drove back the gas.

SECTION IN CRESCENT CITY ARTESIAN WELL.

	Ft.	In.
Soapstone	31	00
Gray sandstone	2	06
Soapstone and shale	37	06
Very hard gray sandstone	1	00
Slaty coal	1	06
Shale	6	00
Gray	44	06
Soft shale	11	00
Soft gray sandstone	18	00
Hard dark sandstone	5	00
Gray flint?	2	00
Dark gray sandstone	62	00
Salt water.		
Hard black shale, (Coal?)	73	00
Gray sandstone	65	00
Flint	6	00
Hard gray shale	5	00
Hard argillaceous sandstone	34	00
Gray shales, (Soapstone)	55	00
COAL. (L?)	1	06
Gray shale and sandstone	134	00
Dark sandstone, with salt water flowing seven gallons per minute, 3° Baume	5	00
Hard pure sandstone conglomerate	50	00
Coal and slate	0	06
Soapstone	10	00
Coal (A?) and slate	1	06
Fire clay		06
	682	00
Surface	17	00
Total	709	00

This bore seems to show irregularities in the rocky strata, and differs from all others put down to a corresponding depth, at the several points explored in this region. It is possible that during the "oil fever" less attention was

paid to what was then esteemed a minor matter, as coal, etc., then we can now wish. However this may be, the section is given for future comparison.

At Avondale, a northern suburb of the city, a bore was put down in April, 1875, with the following results, kindly furnished by H. E. Reed, Esq.:

SECTION IN AVONDALE BORE.

	Ft.	In.
Surface	9	06
Blue clay	30	06
Gray sand	2	06
Blue mud, (quicksand)	22	03
Gravel, sand and shells	6	00
Fire-clay and sand	28	03
Gravel and sand	1	00
Sandstone	2	00
Fire-clay	2	09
Sandstone	11	00
Fire-clay	7	09
Sandstone	7	00
Fire-clay, with pebbles	2	08
Siliceous clay	1	00
Sandstone, with iron balls	72	00
Concretion	1	10
Sandstone	36	10
Rock slate	6	00
Black slate	2	10
Coal	4	00
	256	09

A company was formed which at once commenced sinking a shaft with engine and fixtures of the most approved power and plan. The enterprise was being prosecuted, at the time of my visit, with energy and skill, and had passed the quicksand, overcoming obstacles which required patience, foresight and nerve. Just below the quicksand a wonderful bed of fresh water shells was found, including ten species of muscles, *Paludinum*, *Melania*, etc., a large majority of which now have their habitat in the States that border upon the Gulf of Mexico, and prove conclusively that at an early day, soon after or at the close of the lacustral period, a climate prevailed in southern Indiana similar to that enjoyed by our Southern brethren. This

subject has been herein more fully discussed under head of "Recent Geology." It has since been announced in the newspapers that the company struck the main coal, four feet thick, on the 10th of March, 1876, at a depth of 260 feet.

An account of strata met in the new shaft at Henderson, Ky., ten miles south of Evansville, reported by H. E. Yingst, foreman, and taken with the assistance of G. M. Alves, Esq., John Reichert and George W. Fallen, the latter two, of the company who originated and prosecuted the "People's Mine" enterpise:

SECTION IN "PEOPLE'S MINE" SHAFT.

(HENDERSON, KY.)

	Ft.	In
Yellow clay and sand	10	00
Black peaty soil	4	00
Blue clay	3	00
Yellow clay and quicksand	10	00
Clay and sand, with boulders 1 to 6 inches in diameter, and a great variety of sub-tropical fresh water mussels and univalves	10	00
Porous limestone	1	00
Fire clay parting		03
Blue limestone	2	06
Slate and coal		10
Solid limestone, weathering yellow, fossils	2	06
Fire clay		06
Soft soapstone	4	10
Black slate		02
Soapstone, with limestone boulders	1	06
Shaly sandstone	5	02
Shaly sandstone	30	00
Gray shale	13	00
Black slate	4	00
Coal parting ....0 to	0	04
Hard stony fire clay	3	00
Siliceous shale, with ironstones	27	00
Black slate with fossil shells, and *Stigmaria*, *Lepidodendra* and *Cordaites*	1	08
COAL—worked	4	00
Fire clay	3	00
Hard fine blue limestone to bottom of shaft	3	00
	172	03

The top of "People's mine" shaft is twenty-one feet above high water, and sixty-five above low water in the Ohio. According to surveys made by Mr. Alves, and results in the short entries of this mine, the dip is reversed, and strata rise to south and southwest at the rate of from twenty to a hundred and ten feet per mile. The last may be only a local roll. It is possible that Holloway's bore, put down four miles east of Henderson, to a depth of one thousand and twenty-four feet, pierced successively the coal measures, the upper beds, including St. Louis, of the sub-carboniferous, and rested in the sandstone member of the knobstone groups. A six foot coal, reported one hundred and fifty feet above the bottom, is a black slate, sometimes occurring at that horizon.

Going northwest from Evansville, the rocks pierced at the beginning of Ingleside shaft, are found partly exposed in the bed of Pigeon, and in the sides of the bold bluff which bounds the alluvial valley on the north. The crest of the bluff shows the double limestone, which usually, in counties to the north and west, separated by a space of from ten to forty-four feet, are here brought in contact, by absence of the material generally intervening. They also mark the horizon of the first and second rash coals, here also barren. Above them is the third or local rash coal, and the Merom sandstone. The following exposure was noted at Babytown hill and Phil Koch's quarry:

SECTION AT BABYTOWN.

	Ft.	In.
Soil	10	00
Merom sandstone, (soft)	45	00
Coal, 3d rash, local	1	05
Siliceous shale	3	00
Laminated, sandstone ripple marked; some good quarry stone	19	00
Blue limestone	2	00
Conglomerate, siliceous and ferriferous—place of flint	2	00
Yellow ferruginous limestone	7	00
Siliceous shale to brook	35	00
Total	114	05

Some stone for rough masonry and flags has been quarried on Phil. Koch, Senr's land. The coal is of limited area, but is reported to burn well. The same seam of coal has been worked to a limited extent on land of Phil. Koch, Sen., southwest quarter section 14, township 6, range 1, and D. S. Lytle, same section.

The limestone in foregoing section, and on land of W. H. Law, southeast quarter section 23, township 6, range 4, contains large and small crinoid stems, *Spirifer lineatus*, *Spirifer Kentuckensis*, *Athyris subtilita*, *Terebratula bovidens*, *Productus longispinus*, *Rhynchonella osagensis*, *Lophophyllum proliferum*, *Hemipronites crassus*, *Campophyllum torquium*, ? etc., in fact, is composed almost wholly of marine animal remains, generally so compressed and broken as to be undistinguishable.

From the top of Babytown hill, nearly 200 feet above low water in the river, a splendid view is enjoyed of the city and its teeming life, and the beautiful river bearing on its bosom graceful, life-like steamers, ladened with the commerce of the Valley States. In the village, on land of J. F. Schaefter, northwest quarter of section 23, township 6, range 11, a spring flows from the base of a decomposing mass of limestone, somewhat acidulous, and holding iron and sulphur in solution. It has been used medicinally with success, and will doubtless have good effects in febrile cases.

On Andrew Koch's land, southwest quarter section 14, township 6, range 11, the massive bed of the Merom rock is well exposed, exhibiting one of its typical features. The rock is 20 to 40 feet thick, and is composed of sharp, angular grains of sand, with small partings or veins of soft, hematite, and a few trunks and stems of plants. The sand is but slightly agglutinated, or disintegrating from ancient exposure, is soft and incoherent, and may be removed with a shovel, scarcely requiring the aid of a pick or blast. On exposure, the iron is removed by rain and dew or by washing. The sand is white, clean, excellent for plastering, etc., and may be used for the manufacture of glass. All these

strata dip 60 feet per mile to west, northwest. Absence of the third rash coal in a well, on the same land, proves its area extremely limited.

BABYTOWN WELL.

(A. Koch's land.)

	Ft.	In.
Soil	10	00
Soft, incoherent sandstone	2	00
Soft Merom sandstone, massive bed	43	00
Siliceous shale, no coal	16	00
	71	00

Adjoining, on land of Charles Rodenberg, southwest quarter section 15, township 6, range 11, 4½ miles west of Evansville, a large amount of stone has been quarried and burned, making a strong, dark lime.

SECTION AT RODENBURG'S QUARRY.

	Ft.	In.
Clay and loess	40	00
Merom rock and siliceous shale	20	00
Blue clinky limestone	2	04
Conglomerate, with argillaceous and flinty material, fossils	3	00
Gray limestone, weathering yellow, brecciated, with crushed fossils	5	00
Parting of fossils	0 to 0	02
Gray laminated limestone	4	00
Siliceous shale, ironstone nodules and plates of sandstone	25	00
	101	06

This bed of stone is probably at or about the horizon of the top of the Ingleside shaft. The strata dip rapidly to the west, consequently springs are not found on the eastern, but burst out on the western exposures or hill sides. Continuing southwest on the land of J. W. G. Stinson, the rocks afford the following:

SECTION AT STINSON'S SPRING.

(FOUR MILES WEST OF EVANSVILLE.)

Southwest quarter section 28, township 6, range 11.

	Ft.	In.
Loess and soil	3	00
Merom rock ......14 feet to	6	00
Siliceous shale with nodules	13	00
Upper hard blue limestone	3	02
Parting slate and fire clay, place of second rash coal		04
Yellow limestone with crinoid stems, *Spirifer lineatus*, *Natica*, etc......11 feet to	3	09
Shales and sandstones to brook	22	00
	51	03

Strata locally dip west 60 feet per mile. The Merom sandstone is ferruginous and very coarse, indicating a shore or estuary deposit transported by strong currents or thrown up by breakers. In short spaces the beds are nearly horizontal or sinking with regular dip, but frequent masses ot false or diagonal bedding with a slope of 10° to 35°, faced directly to the west, showing that the deep ocean, whose waves gave direction to this deposit, was in that course.

At Michael Gluck's lime kiln, southwest quarter section 32, township 6, range 11, stone has long been burned, making a good strong lime for local demand. The following out-crop was noted:

	F.	In.
Loess, soil	20	00
Red sand, loess	4	00
Soft Merom sandstone	26	00
Shaly sandstone	12	00
Blue limestone......3 feet to	1	00
Calcareous argillite with plates of chert of 2 inches to 8 inches, and containing *Spirifer lineatus*, *S. Kentuckensis*, *Bellerophon*, *Athyris*, *Productus*, and crinoid stems and arms	3	00
Gray and buff limestone crowded with a crushed mass of above fossils	8	00
Gray shale in brook	2	00
	76	00

Another outcrop of this flinty (hornstone) limerock, was seen further on in the West Franklin road, which has been a noted curiosity with geologists who have made this region famous by their labors. At this point, although not well exposed, it would seem from the sloping outcrops, that the whole thickness of this limestone had passed into clinky hornstone (flint). At southeast quarter section 6, township 7, range 11, the Merom sandstone is seen along the top of the hill, indicating a thickness of twenty to thirty feet.

On the slope of the hill, near the residence of F. Finney, are three sink holes, such as are so common in the region of the subcarboniferous limestone, from ten to thirty feet in diameter. Their size indicates an unusual development of limestone of this locality. These are the only sinks seen in our coal measures. A large spring discharges the water collected by them. At the southwest corner of the county, about a mile east of West Franklin, the bluffs expose a bold precipitous face to the river. The limestones here parted by a slight layer of slate and thin plates of the second rash coal, are elevated with the Merom sandstone by a local anticlinal ridge, with strike from northeast to southwest, and dipping slightly to the east, but rapidly, for a short distance, in the normal western direction. Much stone was formerly burned here, and at the village below, for shipment to the southern market, but this lime contained so much color and foreign ingredients that it could not succesfully compete with the purer article from subcarboniferous. At this bluff, Mr. Geo. M. Priest (to whom I am indebted for section in bore, and other favors), in November, 1859, put down a test well, which, with the outcrops gives a good exhibit of strata, viz:

PRIEST'S BLUFF SECTION.

West half section 19, township 7, range 11.

OUTCROP.

	Ft.	In.
Covered	22	00
Yellow ferriferous Merom rock	15	00
Pyritous clay shale, with plates of sandstone	19	00
Black carbonaceous slate ....1 ft. to	0	00
Blue limestone ....1 ft. to	4	00
Parting, 2d rash coal		06
Buff clinky limestone	5	06
Blue and black shale, 1st rash coal ....1 ft. to	0	00
Siliceous shales with iron nodules	27	00
Bore—high-water mark.		
Siliceous shale, with good iron ore in bands and nodules	36	06
Siliceous shales, with nodules	30	00
Hard concretions	2	00
Sandstone	44	03
Laminated sandstone and shale	13	00
Blue shales	27	00
Very dark shales	3	06
Coal, (N?)	3	06
Fire clay	1	06
Total	254	03

By this it is seen that a coal of workable thickness exists at a depth of 157 feet below high water mark. Just across the line, in Posey county, the rash coals are better exhibited, although of no great importance. They are, at no locality in the State, of workable extent. Near this point, and below, the tops of the hills, 130 feet above the valley, afford a magnificent view, embracing a large extent of river and bottom fields, and have been employed as "look-outs," or residences, by the Mound Builders and other pre-historic races.

Going north along the county line, the Merom sandstone was noted at several localities, generally in Posey county, rising to the northeast and dipping to west southwest. Much diagonal or false bedding was observed with wave faces to west. At Andrew Keck's quarry, northwest

quarter section 36, township 7, range 12, half a mile west of the county line, the massive member of the Merom sandstone is well exposed, and yields an excellent quarry stone, n large blocks, one of the best quarries in the vicinity. In the lower strata *Calamites* and worn trunks of coal plants were seen. Below the quarry is a band of black shale with locally a thin seam of coal from six to ten inches thick.

The same sandstone outcrops on the farms of Charles Keck, Lewis Hauschild and George Roseman, sections 30 and 31, township 6, range 11; soft and incoherent at the top, but presenting massive ledges ten to twenty feet thick, in the ravines. A short distance east of this locality the sandrock ascends to the summit of the hills, and the double limestone and rash coals are exposed in the valleys. Massive beds of sandstone are seen along the southern bluffs of Big creek, some of which have been quarried for rough masonry. At Wm. Fauquher's, and vicinity, section 6, township 6, range 11, the Merom sandstone caps the tops of the hills and a band of black carbonaceous shale, twelve to eighteen inches thick, is seen in the ravines, representatives of the second rash coal of general section, the limestones apparently being absent, or having passed into a calcareous shale. A thin coal was formerly worked, for blacksmiths' use, on the Dow farm, northwest quarter section 1, township 6, range 12.

On the dividing ridge between east and west branches of Big creek, on the farm of Henry Schift, 2½ miles southwest from St. Wendell, the Merom sandstone has not been eroded, and crowns an almost knob-like elevation. The lower strata is soft, micaceous and readily yields to the action of the atmosphere and running water, the middle or massive member, more compact, often stands out 10 to 15 feet, overhanging the brook which rushes past its base, forming "rock houses" like those so often seen in the conglomerate hills. These have been used for shelter in storms by Indians, as well as wild animals. St. Wendell is a German village (section 7, township 5, range 11), and

presents many characteristics of the fatherland, novel to Americans. The industry, thrift and prosperity of the citizens is proverbial. Well appointed farms, good gardens and comfortable or luxurious houses, filled with means for social comfort, enables them to enjoy life somewhat independent of the outside world. Coal has been stripped to a very small extent at several openings near the village, but it is impure, thin, and will not justify expensive work. On the farm of John Tenbarge, west half section 6, township 5, range 11, the second rash coal is found 11 inches thick, of fair quality. At George Helfert's, southwest quarter section 7, township 5, range 11, several loads have been mined; for quality, see chemist's report.

SECTION AT HELFERT'S—ST. WENDELL.

	Ft.	In.
Slope, Merom sandstone	70	00
Calcareous shale (limestone)	1	06
Black sheety shale	2	00
Coal, second rash	1	06
Laminated fire clay, in brook	1	00
	74	06

In the black slate covering this coal was seen dermal tubercles and spines of *Petrodus occidentalis*, *Nucula inflata*, *Cardiamorpha Missouriensis*, etc. The fish specimens above are probably termed "comb-like teeth of sharks" in former reports.

The northwest part of the county, near the residence of Hon. Leroy Calvert, is a prime agricultural region; perhaps, considering all the surroundings, the best in the country. The table land is a broad, gently undulating or nearly level plateau, and offers the characteristics of a prairie opening. The soil produces good crops of grass, wheat, and a fair yield of corn in its natural condition; but many farms have been enriched by under-draining, which assures good crops in spite of unpropitious seasons by fortifying plant life against flood or drought. In this vicinity the valley of Big creek proper is from two to three miles wide, and several of

its branches have valley plains from one to two miles wide, with only brooks or wet weather streams flowing through them, in no way commensurate with the erosion necessary to excavate such water-ways, all pointing back to the time when temporary sluice-ways, discharging floods of ice-water from the northern and northeastern glaciers, swept across here to the Wabash by way of Big creek, now an insignificant stream. The rocks are deeply covered, and the only outcrop noted is a quarry of Merom sandstone on the farm of John Klaser, northwest quarter section 23, township 4, range 11. Well improved farms, comfortable houses and a thrifty people characterize this vicinity.

Returning south towards the city, many vineyards and profitable orchards were noted in the broken and hilly region which borders the ravines. On the farm of Mr. George Graff, northeast quarter, section 22, township 5, range 11, much ill-advised search has been made for silver, and an expensive shaft put down through the solid Merom rock. It is unnecessary to say that there is not the least probability of finding such ore in this county. The following shows the outcrops:

SECTION AT GEORGE GRAFF'S.

	Ft.	In.
Covered and variegated shale	30	00
Soft Merom sandstone	8	00
Laminated Merom sandstone	20	00
Massive Merom sandstone	12	00
Shale and sandstone	3	00
Blue sandstone and shale	7	00
Black slate		08
Coal, rash	1	02
Siliceous shale	4	00
	85	10

The character of the under bed indicates the irregular and unreliable nature of the coal noted in the above section. Although appearing at the horizon of the second rash coal, it is probably a local deposit of no great extent.

On John Kohler's land, southeast quarter, section 3, township 6, range 11, coal was formerly worked at a good deal of expense. The fixtures are not in use, and gone to decay. A specimen of the coal for analysis was not obtained. The following section is nearly correct, viz:

SECTION AT KOHLER'S OLD MINE.

	Ft.	In.
Soil and loess	10	00
Merom rock	25	00
Gray shale	4	00
Coal, rash	1	06
Laminated fire clay	2	00
	42	06

Before the opening of Ingleside shaft, the coal mined here was hauled in wagons to partially supply a light local demand in the city. It is not probable that this coal will pay for working. In Big creek region and along the county line, judging from outcrops seen in Posey county, the space between the first and second rash coals is widened up to from 10 to 40 feet, in some cases to a still greater extent, and the limestone superimposing them, passes into calcareous shales or fossiliferous argilites. No closely connected section was taken showing this feature in the county.

North of Evansville, near the crossing of the Princeton pike over Pidgeon, a sandstone in regular layers is quarried. It is fair stone for foundations and underground work, and easily shaped by reason of its planes of stratification. The following section reaches from the bed of the creek up to and including the double Permo-carboniferous limestone which is seen as boulders or residual red clays along the crest of the hill, but becoming persistent where not exposed to the air:

MECHANICSVILLE—PIGEON SECTION.

Southwest quarter section 8, township 6, range 10.

	Ft.	In.
Clay soil	26	00
Yellow clay	8	00
Blue shale—decomposing shale	8	00
Place of Permo-carboniferous double limestone	5	00
Covered slope, (shale)	40	00
Gray shale	10	00
Banded sandstone, passing into shale	1	06
Gray shale	15	00
Sandstone passing with wedge-shape terminals into shale	11	00
Silicious shale with iron stone nodules	15	00
	114	06

Mechanicsville is a thrifty suburb, elevated 150 feet above the city, and 520 feet above tide-water. The pure air and sunshine is apparent in the ruddy faces and elastic forms of its citizens.

From the top of the hill a wide view is spread out, embracing the city and its spires and factories, the rich, broad valley alive with railway trains, and the river quivering beneath the tread of stately steamers. Across the river in Kentucky, hills twelve to fifteen miles away pierce the blue sky with cones and peaks, apparently 80 to 100 feet higher than this spot, guarding the southern wall of the Ohio valley. A short distance east of the north end of the long narrow village, on northwest quarter section 5, township 6, range 10, the double limestone persistently outcrops in the shallow ravines, and is worked at two quarries. The product is used for curbing and stoning the streets of Evansville. This stratum rises to the northeast at about fifteen feet per mile, and is seen a surface rock two miles northeast of Mechanicsville, and at Andrew Palmer's on the pike. Near Anton Schmitt's, northwest quarter section 20, township 5, range 10, it shows a face of seven or eight feet, and in cavities beneath its disturbed edges, rattlesnakes*

*Col. Hornbrook tells of a fight between two large serpents, one a rattlesnake, the other a blacksnake, witnessed by himself on this farm. It was a fight to the death. The reptiles rearing up nearly erect, maneuvered their heads with swift-winged motion for advantage, and filled the air with sickening smell. The rattler

and other serpents gather every season from an are of miles, to hibernate. One of the former was said to have been ornamented with 26 rattles.

At the residence of J. W. Knowles, Esq., disturbed fragments of Merom sandstone are seen at and on the surface, and the limestone 5 to 9 feet thick on the sides of the hill. His well gives the following:

SECTION IN KNOWLES' WELL.

	Ft.	In.
Soil and red clay	12	00
Merom sandstone	14	00
Soapstone and shale	9	00
Siliceous shale	2	00
Limestone	2	00
	39	00
Add limestone in outcrop	8	00
	47	00

At the southwest corner of Knowles' farm, southwest quarter section 17, township 5, range 10, the massive Merom sandstone over-hangs the brook which flows by its base, forming a rock house, which was a favorite resort of Indians seeking protection from storms. Mr. Knowles' fruit trees are a surer source of income than field crops. He carefully cultivates or preserves some of the native fruits, as persimmon, pecan, etc. At the neighboring residence of Mr. G. Potts, an interesting and well arranged cabinet of fossils, relics, etc., was visited, some of which were of much scientific interest.

Inglefield is situated at the southern edge of the high dividing ridge of table-land, from which the water-shed is to the northwest to the Wabash, and south to the Ohio. It is well up to the summit level of the county. A cut by the railroad, south of the village, exposed strata full of interest. First shales with bands and boulders of siliceous iron stone are seen dipping to the southwest. As they pass from view, their upper surface roughly distorted and water

gave the first blow, but in coiling back for another stroke, exposed his flank. The blacksnake, seeing his opportunity, like lightning, seized his adversary by the back of the neck, and throwing him with thumping sound upon the ground, wound his coil around, boa-constrictor like, and crushed and choked him dead.]

worn, the massive member of the Merom rock superimposes the shales resting on their eroded surface, but unconformably as if of more recent date, perhaps establishing a line between older and more recent geological formations, between the Triassic? and Permo-carboniferous periods.

The Merom rock is itself very irregular, with much false bedding and alternately compact or of friable texture.

No fossils were seen. A bore put down by W. Adams, for the proprietors of Browning's mill of this village, discovered the following extraordinary strata, indicating a prevalence of limestone on this anti-clinal similar to the calcareous beds found in deep bores reported in geology of Gibson county, viz:

INGLEFIELD BORE SECTION.

	Ft.	In.
Surface clay	10	00
Red Merom sandstone	36	00
Carbonaceous parting, coal		04
Hard flinty limestone	4	00
Clay parting, second rash coal	1	08
Flinty gray limestone	6	00
Light gray sandstone	20	00
Soft white limestone	8	00
Soapstone, first rash coal	16	03
Shale	20	00
Gray flinty limestone	3	02
Soapstone	26	00
White limestone	30	00
Gray shale	20	00
Fire clay	10	00
Coal N ?	1	06
Fire clay	4	00
Gray shale	10	00
Soapstone	28	00
Sandstone	3	00
Black slate	2	00
Sandstone	17	00
	276	05

Two and a half miles northeast of Inglefield, near McCutchen school house, section 2, township 5, range 10, and section 34, township 4, range 10, an interesting cluster of pre-historic earthworks exist, which will be more fully noted under the head of antiquities. The double limestone is found in wells, etc., on the table-land in this vicinity, from 20 to 40 feet below the surface. It is seen along hill-sides on the Thomas McCutchen farm, northwest quarter section 25, township 4, range 10, where stone has been burned for lime, and where another winter resort for snakes has been discovered and destroyed.

The top of a bald peak on the McCutchen farm, northwest quarter section 25, commands one of the finest outlooks in the State, embracing the hills and knobs beyond Newburg, 18 miles to the south, Dittany hill, 6 miles to the northeast, the range of wall-like hills along the west line of Pike county, as McGregor's hill, etc., and Kennedy knob, 15 miles to the north, in Gibson county. At each of the last two stations, and at Snake knob, sections were taken and given in reports on Pike and Gibson counties, which are by this survey and by stratifications here noted, connected with the survey of Vanderburg; for the double limestone which caps the top of each of these hills is seen ascending to the northeast, and as it approaches the intervening valley of Pidgeon, passes out above the surface two and a quarter miles east southeast of Eberfield, in Warrick county. At Dittany hill, in Warrick county, interesting phenomena are observable, some accounts of which are given under the head of recent geology.

Passing down Pidgeon creek, the rocks were concealed by float materials. At Millersburg, in Warrick county, coal of superior quality (for analysis see chemist's report), was worked during the short life of the canal, and is still used for local fuel. This coal is apparently our nearest approach to Pittsburg coal. The following section was taken near Mischke's mill:

SECTION AT MILLERSBURG.

(WARRICK COUNTY).

			Ft.	In.
Slope and argillaceous shale			12	00
Pyritous argillite			1	00
Black clod fossils			1	00
COAL N:				
Laminated good coal	1	04		
Choice cubic coal	1	06		
Rash pyritous coal		06		
			3	04
Argillite, with pockets of impure coal			5	00
Gray shale			2	00
Blue limestone, very hard and ferruginous			5	00
Total			29	04

In the black clod over coal N, were noticed some beautiful pyritized specimens of *Myalina*, *Aviculopecten*, *Productus*, *Chonetes*, *Macrocheilus*, *Rhynchonella*, *Spirifer* and *Nautilus*, with *Neuropteris*, *Pecopteris*, *Alethopteris*, *Cordaites*, *Sigillaria*, etc. In the limestone a few crushed specimens of *Spirifer*, *Productus*, *Athyris*, with crinoid stems, were observed. In the village, a number of ancient mounds were visited.

At Chandler station, on the Boonville railway, a new shaft had just been put in successful operation by the proprietors, Pattison & Williams. The fixtures are first-class, driven by an engine of forty horse power. They were mining 50 to 60 tons a day, and as soon as the entries, which were in progress, could be finished, the capacity would be equal to an output of 200 tons a day. The company carefully select and reject the pyrite and other impurities, desiring to sell only a good article, and furnish a good coal for steam and grate use; for analysis see chemist's report. I am indebted to Mr. H. E. Williams, superintendent, for the following sections, and other favors.

CHANDLER SHAFT.

(WARRICK COUNTY.)

			Ft.	In.
Clay soil			16	00
Coal N. Millersburg and "Little Newburg"			2	00
Fire clay			2	06
Blue dark limestone with *Spirifer cameratus, S. lineatus, Athyris, Chonetes* and crinoid stems			9	05
Soapstone, (indurated shale)			4	00
Hard sandstone			3	00
Light soapstone				08
Siliceous shale			11	10
Sandstone			5	03
Gray shale			10	05
Dark soapstone			2	01
Gray shale with plates of sandrock			34	00
Black slate			1	00
Slaty clod, with large boulders				08
COAL M.				
Fair coal	1	04		
Pyrite parting 0 to		02		
Good coal	1	04		
Laminated coal	1	04		
			4	02
Fire clay			4	00
Siliceous shale, iron nodules			5	00
			116	00

This is an excellent, strong coal. Care should be used to reject the band of pyrite, when the product will command a ready market.

The following section was taken at Newburg near the southeast corner of the county. Most of the strata are seen in out-crops. Thanks are returned to Mr. Love, proprietor, for a report of strata in shaft. The small seam, N, is 80 feet above low water in the Ohio, 30 feet above high water and 10 feet above the top of the shaft.

SECTION AT NEWBURG SHAFT.

	Ft.	In.
Massive yellow sandstone	18	00
Gray shale	16	00
Black slate and fire clay	2	00

COAL N. "Little Newburg"			1	04
Fire clay			5	00
(TOP OF SHAFT.)				
Gray and buff limestone			8	00
Gray shale with plates of sandstone			88	00
Hard slate, pyritous fossils			1	00
COAL M.				
Fair coal	1	10		
Pyritous parting		02		
Good coal	2	00		
			4	00
Fire clay			2	00
Siliceous shale, pyrite pebbles			3	00
			148	04

The limestone under coal N is rich in the coral, *Chætetes*, and contains a few specimens of *Lophophyllum* of exaggerated size, in some individuals, the diameter of the calices would range from three-fourths to an inch and a quarter. According to the Cypress creek bore, a short distance east of the shaft, coal L is 123 feet below M, K 60 feet below L, and the conglomerate ? sandstone 112 feet below K.

On the land of Silas Stevens, northwest quarter section 7, township 6, range 9, seven miles northeast from Evansville, a shaft was put down to coal N and formerly operated. The coal, too thin to be worked in competition with the thicker seams, was reported to be of superior quality—a rich, fat caking coal, full of gas. The shaft was abandoned and could not be entered without help. The following is the reported section, and neighboring outcrops confirm the report:

SECTION AT STEVEN'S SHAFT.

	Ft.	In.
Covered soil	8	00
Choice yellow sandstone	22	00
Siliceous shale with iron shells	10	00
(Top of shaft.)		
Gray and buff, siliceous and also shales, with thin shells and plates of iron stone	19	00
Black slaty clod	1	00
Coal N	2	03
Fire clay in brook	2	06
	54	09

This coal is very like the Millersburg coal; for analysis see that coal. In the brook, shelly or concretionary iron ore in fragments was abundant, equivalent to similar outcrops seen at Millersburg and 130 feet below the top at Dittany hill, marking the horizon of coal N. The yellow sandstone in section has here been worked. The stone is a superior article of sandstone, regularly bedded, and may be readily and cheaply split or broken to "dimensions." Natural exposures show that it is durable and valuable.

ECONOMIC GEOLOGY.

Evansville, the county seat, is one of the principal cities of the State, and commercially, takes the first rank. It is situated on the north bank of the Ohio river, in latitude 38° 8′ north, and longitude 10° 30′ west from Washington. The altitude of the Ohio at low water is 320 feet above the ocean. The elevation of Main street is 50 feet above low water, and consequently, the average altitude of the city above tide-water is 370 feet.

As early as 1812, a few settlers gathered about the wilderness site of the city, and in 1820, there were only 100 inhabitants. About 1830 it took new life, when the rich Wabash valley, then just settled, sent down its wonderful productions to glut the New Orleans market. In 1840, the population was 2,121; in 1850, 3,235; in 1860, it had reached 11,468; in 1870, 28,715; and now, 1876, is fairly estimated at 42,000. Such figures signalize not only the growth of the city, but also, wealth, for investments, increasing with population, have consequently averaged more than 100 per centum advance in each decade. This growth is due to a variety of causes which will be briefly hinted at. The citizens, with a heritage of pioneer spirit, have bravely overcome natural drawbacks—averted the malarious exhalations natural to their alluvial situation, by a magnificent system of sewerage, in health worth twice its cost, have rejected the impure and unhealthy surface-water, and secured pure water by first-class works, have conquered nature by dredging flint gravel from the bed of

the river, and making first class streets and pikes radiating to every point of the compass, have encouraged and sustained the manufacture, at home, of every native production, and finally, urged by their favorable situation on the Ohio, below interrupting rapids and ice, and near the outlet of the Wabash, Green and Tennessee rivers, combining a navigation of more than 2,000 miles, have, by their skill and energy, seized upon the boating transportation, and "made commerce king." By facilities for trade, a large area of southwestern Indiana, southern Illinois, western Kentucky and some portions of nine other States to the south and west, are rendered tributary to her trade; prospering and receiving benefits in return.

The latest (1874) statistical compilations* available, although not as full as desirable, gives an illustration of manufactures and vigorous commerce, amounting in the aggregate to over $50,000,000 per annum:

MANUFACTURE AND TRADE OF EVANSVILLE.

Agricultural Implements and Seeds	$500,000
Ale, Bottled	71,000
Architectural Castings	40,000
Auction and Commission	608,723
Beer and Malt Liquors	690,000
Books and Stationery	135,000
Boots and Shoes	1,500,000
Bottled Sauces, Table Notions, etc	8,000
Brass Manufactures	125,000
Bricks "	200,000
Brooms "	15,000
Building Improvements	3,000,000
Carpets, Oil Cloths, etc	200,000
Carriages	130,000
China and Queensware	500,000
Clothing	1,250,000
Coach Trimmings and Horse Goods	100,000
Coal—Its Local Trade	173,845
Confectionery	400,000
Cooperage, Staves, Shingles, etc	150,000
Cotton Fabrics, manufactured	150,000

*Roberts' "Evansville, her Commerce," etc., 554 pages. Octavo.

Dry Goods and Notions	$5,100,000
Drugs and Chemicals	1,100,000
Engines, Boilers and Machinery	1,091,000
Enameled Grates and Mantels	10,000
Edge Tools and Cutlery	40,000
Furniture and Chairs	825,000
Grain and Flour	5,075,000
Groceries	6,000,000
Galvanized Iron Cornice	60,000
Hair Goods	15,000
Hardware, Jobbing	600,000
Hats, Caps, Furs and Straw Goods	600,000
Hogs and Provisions	500,000
Hosiery	13,000
Ice	140,000
Iron, Merchant and Heavy hardware	350,000
Iron Pumps	3,500
Iron Railing and Jail Work	15,000
Iron Safes and Bedsteads	11,500
Jewelry, Watches, Silverware, etc	200,000
Leather, Hides and Oil	500,000
Lightning Rods	5,000
Liquors and Wines	3,500,000
Marble and Building Stone	135,000
Millinery	40,000
Music and Musical Instruments	100,000
Paper, Blank Books, Binding, etc	260,000
Paper Wrapping	5,000
Plows	145,000
Produce—Wool, Feathers, etc	300,000
Realty Sales	2,307,562
Saddlery and Saddlery Hardware	500,000
Salt, Lime, Cement and Plaster	200,000
Sewing Machines	170,000
Ship Chandlery, Boat Stores, etc	150,000
Soap and Candles	60,000
Steam, Gas and Water Fixtures	45,000
Stoves and Hollow-ware	640,000
Sugar Cane Machinery	30,000
Terra Cotta and Stoneware	30,000
Tin, Copper and Sheet-Iron Ware	500,000
Tobacco and Cigars	3,545,000
Toys, Fancy Goods and Fire Work	50,000
Trunks	30,000
Wagons, Wheels, Hubs, etc	75,000
Wall Paper, Window Shades, etc	100,000
Wood, Lumber, etc	3,000,000

Woolen Fabrics, manufactured	$125,000
Miscellaneous Retail Trade Estimate	2,000,000
Various Manufactures not specially detailed	2,225,000
Total	$52,477,130

Banking facilities are already at hand equal to this business. The churches are numerous, chaste and substantial. Her public schools are equal to the best; her street railways are extensive; her hotels and opera house scarcely equaled by any city of the same size, and with over 300 extensive and prosperous manufacturing establishments, her growth has only begun. The present is but an indication of the grand future when Evansville shall be queen of the lower Ohio. The total bonded debt of this city is reported at $1,600,000, for which she has property and public improvements worth double their cost, but fairly valued at $2,800,000.

In addition to all these, a great need invites the citizens to new enterprise. A railway bridge, crossing the Ohio, is a necessity long felt that will almost double the present prosperity of the people, and must be at once built here or at some wiser rival city.

COAL.

The mineral resources of the county are apparent from the foregoing geological sections—little more need be added. It may be repeated that the main coal seam, M, is of great and almost uninterrupted persistence throughout the county wherever sought. Barren places may be found, but from present indications such a case will be exceptional to the general rule—i. e., a four foot seam of strong, workable coal underruns nearly the whole area of the county. In other regions faults and "barrens" are large and expensive elements in the cost of coal. Nature has generously, and with full hand, taken off this tax and assures cheap fuel. Coal is the source of England's pre-eminence, and of Belgium's wealth; it is the food of steam, the great slave of humanity. Here the offering is unlimited, cheaply accessible, and quality good, elements of prosperity granted to few of the great

manufacturing cities of the world, and which earnestly invite skilled laborers to this harvest. In addition to the 300 prosperous and profitable manufacturing enterprises already established in the city, it may be suggested that a "plant" for *grinding, working and coking* the nut and other coals is desirable. Coke is urgently demanded by many trades. In fact, the future prosperity of every manufactory, directly or indirectly, depends on cheap coke, and no greater benefaction can be conferred on our region, than a successful demonstration of that quality in our coals. Coke is also wanted in unlimited quantities in the mineral regions of the West. A thousand carloads per month are carried by our doors to the gold and silver works of Eldorado. The precious metals should pay tribute to our black diamonds, and acknowledge the superior value of the latter.

Coal N is thin, not averaging much over two feet, but superior as a grate or coking coal, rich in volatile matter, and contains but little sulphur. It is found desirable for family use, by tidy housekeepers, and, with extended deodorizing surfaces, may and will be used for gas. Tests made when the Millersburg coal was accessible by canal, were favorable.

STONE.

The sandstones of this county are mentioned at several localities. It is generally found in masses or layers of suitable thickness for work. It is well adapted for foundations, etc., and extensive quarries may be profitably opened in the hills, six to seven miles northeast of the city. The Merom sandstone, as a rule, is not a good stone, as it readily disintegrates. The upper limestones have been used for curbing, and will be needed for rip-raps and flood guards. The beautiful cream-colored stone fronts and trimmings, which add so much to the architectural appearance of the public buildings, stores, churches and private residences, are from the thick beds of St. Louis limestone, of the sub-carboniferous group, found abundantly in adjoining regions in this State and Kentucky. This stone is cut by saw, works well under the chisel, and is tough and durable. It is here

a cheap building material. Clay for bricks is found abundantly throughout the county; the quality is good. Modified clays are found in several of the valley lands, and are of superior quality for crocks and jars. The under clays of the coals will furnish an article suitable for terra cotta work and stoneware, which will rival the coals in value.

METALS.

Iron ores are found throughout the coal measures. Nodular ore of good quality occurs just above and below the horizon of coal N. In the present state of affairs, it will not pay to work. The largest deposit seen, was at Priest's bluff, in southwestern corner of the county, where several car loads are exposed at low water. Very minute scales of gold and nuggets of copper are sometimes found, imported with the modified detritus of the glacial drift. It is scarcely necessary to say, that there is no probability and scarcely any possibility that ores of copper, lead or silver exist in this county, certainly not in economic quantities.

SAND.

Sand is abundant on the bars of the creeks and river. It is easily and cheaply "elevated" from the bottom of the latter, by steam. From the decomposition of the Merom rock, a sharp angular sand is obtained, desirable for strong masonry, plastering, etc., which may be economically used for making glass.

ROAD MATERIALS.

There are no gravel beds in the county like those so common in the drift regions in the central and northern parts of the State, but in the bed of the Ohio river and generally below low water, are extensive deposits of ferruginous 'chert, broken in "nut" fragments, torn from the chert beds of the sub-carboniferous higher up the river and carried and rolled here by floods. This is one of the best stones known for metalling pikes and streets. The surface, when compressed by use, is soon re-cemented by the iron it

contains, making a compact, smooth surface, nearly impervious to air and moisture, and slightly elastic. It is extensively used in the city, and conjointly by the city and county authorities. Free pikes radiate in every direction leading to and from Evansville. These are the best public works in the county, for, civilization, social refinement and intelligence dwell only on good roads, avoiding inaccessible or impassable regions. This is proven by the concentration of homes and population along highways even to the neglect of many fertile regions.

WATER.

Mention has already been made of some deleterious minerals liable to be found after seasons of drought in wells on the lacustral clays and sands, creating a predisposition to inflammatory diseases. Citizens can not be too earnestly urged to secure pure water for culinary as well as drinking purposes, and for their stock. Assurances have been given that a filtering cistern, holding and collecting rain water, will often save its cost in a single year, at the expense of the doctors and pill venders.

HEALTH.

The health of Evansville, since a general system of drainage and sewerage was adopted, is good, and compares favorably with other large cities. The low lands, river bottoms, etc., are liable to malarial diseases. Experience shows that the cause of such disease while readily circulating in, is heavier and floats only in the lower stratum of air, and is most active at night; consequently, the evil effects of malaria, even in the low lands, may in a measure be avoided by arranging sleeping rooms at an elevation of ten to twenty feet from the ground.

TIMBER.

The forests of this county have been noted in the general description. They afford one of the great sources of income. Ornamental woods, as walnut, oak, maple, beach, ash, etc.,

are common, and several of the most prosperous manufacturing establishments are engaged converting this home material into useful and ornamental furniture. Other kinds of timber are used for building purposes, the manufacture of wagons, carriages, plows, implements and machines. The sales, direct and indirect, credited to the forests amount annually to over $4,000,000.

AGRICULTURE.

Although overshadowed by the grand achievements of commerce and manufactures, the farmer finds agriculture an honorable and profitable avocation. The skilled husbandman is sure of fair crops, and located at a central distributing point, he is certain of satisfactory prices. Market gardening on land well underdrained is highly profitable, and never equal to the home demand. The progressive farmers in the "flat" areas, are making their uplands equal to river bottoms by tiling.

FRUIT.

The natural advantages in soil, warm climate and command of an unfilled market are neglected—perhaps for the reason that other pursuits are more quickly remunerative. The "bluff" soil of this region is the American equivalent to the Loess of the Rhine which produces the generous wines of France, and with the same care will as richly reward. The climate is in the neutral zone, between uncomfortable warmth and cold, not subject to the extreme changes which renders the business hazardous in more exposed regions. Hence, the tender fruits, as peach, apricot and grape may be grown to perfection along with the sturdier apple and quince. The market is unfilled—east, west, north and south—and with daily means of access. Under the control of those who know how to use them, these advantages ought to make Vanderburg county a "pomological paradise."

Some attention has been given to the subject, and a few very profitable orchards and vineyards were observed. Wines from the latter were rich in boquet and spirit. Trees and vines should be mulched with sawdust, etc., to

protect the roots from the hot sun of summer, and to retain moisture. Numerous native fruits invite attention. Walnuts and hickory nuts command a ready market, and the pecan flourishes and may be easily and profitably cultivated. Wild grapes, plums, etc., crown the hill tops or cluster in the valleys, but the luscious persimmon, "*God's fruit,*" is the plentiest and best. The last presents two varieties—the late and the early—which contains generally but one seed, and is large, sweet and palatable. It is believed that selection by cultivation would produce persimmons rivaling the date. Before drying, the fruit should be slightly scalded in an alkaline solution.

TRANSPORTATION.

The system of commercial intercourse is almost complete. The Evansville & Chicago railway furnishes direct connection with the north, northeast and northwest, 500 to 800 miles away; Evansville & Nashville railway connects with the extreme gulf States, 300 to 400 miles to the south; the Evansville & St. Louis points directly to the grand treasures of the west, and the Boonville and Newburg roads are intended to open a close connection with the east. These railways, with their mighty traffic, would seem sufficient, but to these must be added a fleet of steamers, which "walk the waters like a thing of life," 64 in number, with 18 barges, having a total tonnage of 14,240 tons, owned by citizens of the county, and subsidiary to its interests. These, with as many others from neighboring cities, explore our great system of river navigation, 10,000 miles in extent, exchanging the manufactures and goods of Evansville for the crude products of their neighbors.

ANTIQUITIES.

Several earthworks exist in this county—isolated or clustered mounds and pits, which require for their excavation the persistent labor of a people with a combined purpose under intelligent direction. In their location, embracing healthy and picturesque stations, convenient to

water, generally to river transportation, fertile lands, and a wide outlook to the east; characteristics so constant as to indicate a design, and indistinctly to reveal the religion, government and habits of a mysterious, unknown race. Of these remains the savages knew nothing. Their nomadic life and restless habits forbid such works.

Several isolated mounds were noted on the bluffs, 130 to 170 feet above the Ohio, at the southwest corner of the county, near West Franklin. Implements of stone and pottery found here, were of artistic execution. A celt, (hand axe), of flint was polished like the Danish celts, (unusual in America, if not unique), also a granitic hand axe with beveled edges. A cluster of mounds of great interest was observed near McCutchen school house, two and a half miles northeast of Inglefield, twelve miles from Evansville, on northeast quarter of section 2 and 3, township 5, range 10, and south half of section 34, township 4, range 10, about twenty-five in number. They were scattered over fifty or more acres, and covered with forest and bush. Fifteen were counted, measuring from 2 to 6 feet in hight, and 20 to 60 feet in diameter. On the adjoining Hillyard farm are two pits or excavations, now partially filled. One of them was 60 feet in diameter, and, at first settlement, 20 feet deep, now only ten feet deep. The second was 15 feet in diameter and four feet deep, apparently for underground homes, or for water. A constant spring—rare in this vicinity—seems to have invited the mound builders to this elevated and commanding point, which is a promontory of the dividing ridge which separates the watershed of the Wabash from that of the Ohio. The outlook embraces the wide flat valley of Blue Grass creek, and the distant mound-capped knobs in the horizon. The excavations probably existed first as sink holes through the underlying limestone, and afterward were shaped for human use. An examination can alone definitely settle this question. One of the mounds has been opened. It contained, near the base, ashes, shells, bones and pottery, indicating a mound of habitation. Many relics, well wrought in stone, are reported to have been found in this vicinity.

The extreme northeastern corner of the county was a favorite resort of the pre-historic races. Mr. Jno. B. Locke has collected some interesting stone relics on his farm, northeast quarter section 24, township 4, range 10, found on a knoll in a small mound, including a sandstone pipe or calumet, in shape of " bear's head," ears erect, mouth distinct and claws folded as if hibernating; also, a " medicine" tube of Alabama talc, three and one-half inches long, three-fourths of an inch in diameter at the " mouthpiece," nearly two inches at the opposite end, with a constriction above the middle, the bottom edge was serrate; also, flattened discs of sandstone. On visiting the locality, a bed of whitish clay was seen at the western extremity of a ridge 600 feet long by 200 from north to south. In front of this to east was an area, the surface level and apparently paved with plastic clay 500 by 200 feet, probably a " Chungke play-ground," with council chamber, where the relics were obtained. On this " play-ground " a set of six " Chungke " stones were found from three to four inches in diameter, two inches thick, with a concavity in each side like the quoit or discus of the Olympian games. Surrounding or at the edges, spear and arrow points and " flint chips " have been noticed. This " Chungke" ground is now a field in cultivation. At an early day it was covered with a growth of trees, none over 400 years of age—youngsters compared with the surrounding forests—indicating that this area had been used within 1000 years. At an arrow factory on T. B. McCutcheon's land adjoining, flint "chips" in quantity are reported, also flint " splinters" two to three inches long and perfect as if cut with a knife, instead of by cleavage.

Some interesting mounds were noticed in and adjoining the village of Millersburg. They were composed in part of sand.

At the extreme southeastern corner of the county, extending across the line into Warrick, is one of the most interesting earthworks seen. Angell's mound, on farm of Ham. Angell, southeast quarter section 31, township 6, range 9, is a wonder. A symmetrical cone rising up from the level plain to

a hight of 50 feet, and only 300 feet in diameter. It is almost too grand to be attributed to the puny arm of man. Many smaller mounds, but larger than the general average, are located on the Gen. Lane farm, adjoining the Angell on the east. In this neighborhood are found vases, jars, jugs, implement handles, images of duck and owl heads, human faces and hands, spindle whorls, pipes and buttons, made in pottery; also buttons of cannel coal, and axes, hoes, spades, pestles, grinders, celts, arrow and spear points of stone. Graves of savage Indians are discovered throughout the county, sometimes intruders upon the mounds, but shallow and carelessly made.

Ossuaries or bone vaults have been discovered a few miles west of Evansville. They are isolated or often intrusive on the mounds. They contain the bones of all a nation's dead for a certain length of time, generally seven years, collected from temporary places of deposit at the mid-summer season of cheerless fasting and mourning, cleaned, bleached and deposited in walled vaults covered with flat stones and earth. Older than the Indian period, and later than the mound builders, they belong to an intermediate litoral or riparian race, who retained some of the religion and art of their dispossessed predecessors, but their coarse, crude implements and pottery show that they were far lower in the scale of progress than the latter. They are closely allied to the Natches and Choctaws of DeSoto's expedition.

Thanks are returned to the citizens generally for information and assistance. Acknowledgements for special favors are due to the following gentlemen: Col. Philip Hornbrook, John Ingle, Ingle Bros., Dr. Stinson, Capt. H. E. Leed, Hon. J. D. Riggs, Hon. H. C. Gooding, Sebastian Henrichs, Joseph Hennel, Wm. Fauquher, James W. Knowles, H. E. Williams, of Vanderburg and Warrick; to John Reichert, G. M. Alves, of Henderson, and to the President and Directors of the E. & C. and E. T. H. & C. railroad companies.

OWEN COUNTY.

BY JOHN COLLETT.

Owen county contains 396 square miles, and is bounded north by Putnam, east by Morgan and Monroe, south by Green, and west by Clay county. Spencer, on the west bank of White river, is the county seat, and is 53 miles southwest from Indianapolis. White river is the chief water course. It enters the county from the northeast, near the middle of the east line, where also it forms the division between the counties of Morgan and Monroe, thence it flows southwest with many windings that result in a valley line nearly direct. The bluff walls of this valley are as a rule precipitous, built up with massive strata of stone from 80 to 110 feet. Raccoon, Mills and McCormack creeks flow through narrow rocky chasms into the river from the south, and Indian, Limestone, Mill, Rattlesnake and Fish creeks flow into it on the west side, generally with course directly from the north, the first taking their direction from the general dip of the rocky formations, while the second set of streams owe their origin to causes which will be noted under the head of Glacial drift. Eel river takes rise near Alaska, in the extreme northeastern part of the county, flows west with no deep cuts through a broad level plain largely built up with recent fluviatile or lacustral sediment to Cataract. Here, plunging down the successive falls, it has hewn a passway through a very narrow channel, surmounted by steep or perpendicular sides. This river flows across or around three sides of the county, in more than a great semicircle. Its affluents are Jordan, Six-mile and Fish creeks.

Many springs break out in great volume on the east side of the valleys, conveyed by impervious strata which, dipping generally to the west, account for their position. The water is pure, cold and sparkling, and invites the attention of dairymen and butter makers. It is apparent that this region is well watered, and that the supply is more reliable than in the drift areas. The surface features are agreeably diversified. Rich alluvial bottoms from one-fourth to one-half of a mile wide are found on either side of White river; the small creeks have valleys of no great extent. Near Alaska and Quincy, in the northeastern parts, a rolling or gently undulating area slopes off to the broad, level valley plain of Eel river to the west and north, a fine body of land, producing fair crops of corn and wheat, and an excellent growth of grass.

A similar area about Patricksburg and the extreme west line of the county, slopes gently to the west, and comprises some choice black lands, which produce excellent crops of corn, wheat, oats and grass.

From the northwestern corner of the county to the southeastern, a broad belt of from six to ten miles wide, embraces a hilly, almost mountainous region, in which high hills and deep valleys alternate in close succession. It presents many extensive views full of wild and picturesque beauty. From a point on the divide some distance northeast of Patricksburg, an illusion having an important bearing on the past geologic history of the county, was noticed. Thence the surface of the elevated areas and ridge tops sloped gently to every point of the compass. The deep ravines were hidden by the wall-like ridges with their mantles of tree and bush, leaving no hint of the profound valleys 180 to 250 feet deep, which largely occupy this area.

From that standpoint was revealed the ancient rocky surface of the county as it came from the hand of nature, modeled in the bosom of the ocean, a great plain sloping gently to the west, northwest and southwest, before the currents of ice water, in the glacial age, demanding egress

to the south, had eroded their deep valleys. The scene was not less remarkable for the extensive view enjoyed. Sheriff Moffett, who was familiar with the whole region, pointed out the highlands near Gosport in the northeast part of the county, Cantwell's hill near Santa Fe, Spangler's hill at Cataract, the elevated plateau near Atkinsonville, the ridge east of White river, southeast from Spencer and two knobs like clouds in the blue distance, one just south of Freedom, the other 18 miles away in Greene county.

Although level areas in this belt are not of great extent, several large farms were observed, which, under wise direction, were yielding good returns. The hilly region is better adapted to special pursuits than to general farming. When plowed, the loose soil is inclined to "run" with every shower, and so managed, will, in time, strip off the soil and expose the underlying rocks. This course is destructive. On the other hand, if the attention of the citizens was turned to wool growing and dairying, the soil would not deteriorate, but, according to the Spanish axiom, "The sheep treads with a golden hoof the soil," it may be indefinitely improved. In part of this region, farmers complain that blue-grass and timothy fail, and that clover injures the soil by increasing its liability to "run." It is suggested that orchard grass is a sufficient substitute for the first, and Chilian clover (true Alfalfa) will furnish a substitute for the latter and a perennial forage plant. The red soils of this district are rich in calcareous matter and very fertile in their original (natural) condition. This is proven by the magnificent forests which once prevailed—nearly gone. Some giants of this royal race were observed and measured. Poplars from 5 to seven feet, white oaks from 4 to 6 feet in diameter, with trunks carrying their size well from 50 to 80 feet in length; walnut and other valuable trees of good size were seen, and sassafras trees, generally known as a shrub or bush, having the wonderful diameter of over 3 feet. Such indications should not be neglected. They are a hopeful indication that the old fertility may be

restored by shading the ground from the hot sun by pasturage grasses.

RECENT GEOLOGY.

Recollecting the fact, mentioned in the foreging general description, that the original surface presentation of this county, as it emerged from the mother carboniferous ocean, was a great plain, sloping gently to the west, with two slight ridges guarding to the north and south, the depression or gulf-like basin, 3 or four miles wide, about and west of Patricksburg, in which the block coals were prepared and deposited, the question naturally occurs, to what causes may the well developed system of hills and valleys be attributed. There is no evidence of volcanic energy; little or none of earthquake action, except the slow, gentle oscillations, by which the crust of the earth is continuously raised or depressed over large areas, continentally. Close observation will at once discover agencies, in the long past, of adequate power. The elements are nature's great agents—water, air and heat: ice her great plow, water her graver, and air and heat her moulder. With them and time, she has accomplished the denudation and erosion of mountain, plain and valley. We have but little knowledge of the long period which followed the emergence of this region, till the Glacial age. We know that it was long enough for the Permian, Triassic, Jurassic, Cretaceous and Tertiary seas, in the great valley of the continent, to the west, to develop and sustain their wondrous life under a tropic clime. This was followed by a period of intense cold, which has left many records of existence, graven with a pen of ice, "on the rocks forever."

THE GLACIAL EPOCH.

This epoch on our continent is divided into two periods —the first, in which a deep massive river of solid ice flowed up the St. Lawrence valley, plowed out the beds of Lake Ontario and Erie, resting its ice foot along a ridge still seen in northern Ohio and northeastern Indiana, and discharging

a flood of ice-water, melted by the warmth of each recurring summer's sun, by sluice-ways (present river valleys) into the Ohio and Wabash rivers. Last summer I had the pleasure of studying some of the most interesting phenomena of this period, under the guidance of Dr. Newberry, the accomplished chief of the Ohio geological survey. At Put-in-Bay and Kelley's islands, vast surfaces are planed off smooth as a floor, others grooved and striated, each mark indexing the course and initial point of the mighty ice machine, aud recording a mysterious chapter of the book of nature. The general course of this flood was along the axis of these two lakes, and an average of the observations made was, that its direction was south 80° west. Of this period we have only fragmentary evidence in this State, a single nugget of magnetite from the Adirondacks, a few flat, oval pebbles apparently from the Medina sandstone, some well-defined sluice-ways in Ohio and Indiana; but we may add that many of the actual streams—more of the old river beds and valleys of the State have the general direction of the first flow. In this county, an ancient river flowing west has crossed the top of the conglomerate ridge a mile west of Cataract, scalping clean the surface material, it has left exposed as a clean floor the quartzite under coal A. Going west, we find fragments of this hard stone with identifying fossils, and extensive beds of sand, as if the high-water line of a stream on the high lands north of Jordan. The latter and Six-mile creeks have great valley plains within their high bluffs, far beyond the usitude of the actual streams, even many times wider than the valley of White river below Spencer, and the bed of Six-mile, as shown by bores, was excavated to a depth of from 50 to 80 feet below its own and the level of the chief water courses surrounding. It is suggested that these phenomena may be referred to the first glacial period.

Of the second glacial period, the evidence is apparent to the careless observer. The records are easily read. It was subsequent to the St. Lawrence flow, for on the Bay islands, the southern shore of Lake Erie and where else observed,

its striæ over-ride, and its debris obliterate, the marks and channels of the latter. It come from the extreme north, loaded with Arctic granites. Crossing Lake Superior, it took up iron ore, copper, greenstone and pudding stones from Keweenaw Point and the Manitouline islands. Divided by the peninsula of Michigan, the larger stream flowed solidly up lake Michigan, hewing out its bed, and thence pushed by congelation in the rear or drawn by the ice vacuum in front, poured its rigid current over the northern half of Indiana and Illinois. Probably of extreme thickness at the north, the ice sheet did not have a hight of over 200 to 400 feet in central Indiana, as measured by the Glaciometer* in Brown county. For a probably short time the ice sheet extended over nearly the entire area of the county. Glacial striæ, cut in conglomerate, were seen in the barn-yard of John Haxton, Esq., in southeast quarter section 20, township 9, range 5, the striæ having a confused direction of south 18° east to south 46° east. This southern limit is extreme. But little glacial debris was seen south of Atkinsonville and Santa Fe. It is probable that the foot of the ice flow for a long time lodged, and was heaped up against the ridge running east and west through Spangler's hill just south of Cataract, where the wintry accumulation was melted and discharged down Mill, Rattlesnake, Fish and Lick creek valleys. The ice-water of summer, in flood like torrents, following the direct path marked by the ice, flowed directly south to and sometimes across the present valley of White river. Confirming the conclusion, an interesting set of north–south "passes" were observed, cutting at right angles, and checkering the ridges between those more ancient sluice-ways of the ice age, Jordan and Six-mile valleys, and leading thence to the head waters of Fish and Lick creeks. Very minute quartz pebbles and other comminuted relics of the imported rocks were seen on the head waters of these streams, on Rattlesnake creek, and on the ridge near Atkinsonville, showing conclusively that these valleys were ice-water sluice-ways, and that their

* Ind. Rep., 1874, fol. 82.

origin is due to the violent floods which swept from the foot of the glaciers. To-day a cut of less than 70 feet would carry the water of Eel river, above the falls, through the the pass east of Spangler's hill, into Rattlesnake, its old channel. Near the mouth of that creek and in the town of Spencer, fragments of quartzite under clay of coal A were observed, which had undoubtedly been torn from the dividing ridge near Cataract, and carried thence by the ice waters via Rattlesnake creek. At the same time, White river, following the course of the soft Chester sandstone, at an elevation of 130 feet above its present channel, flowed up McCormack creek, through the "Flat woods," and down Raccoon to the wide channel below. Glacial pebbles sustaining this view were noticed along the banks of the latter stream, as also some fossils peculiar to the knobstone beds of Brown county, which seem to indicate that Beanblossom had once crossed from near Ellettsville to the "Flat woods," and found discharge also by Raccoon creek.

That the valleys of Eel, below the cataracts, and of White river, below the mouth of McCormack creek, are recent, much more recent than that above, is obvious. They are at once contracted to from one-fourth to one-twentieth their former width, that is, the width of the ancient channel higher up stream. The question at once arises, how was the new channel obtained? During the evident long period that the foot of the glacier rested against cataract ridge and the highlands in the north part of Monroe county, the continuous retreating and advancing process of the ice scooped out a deep, wide basin in White river, east of Gosport, and north and east of Cataract, just as the basins of the lakes were excavated, far below the river and outlet. As the ice by climatic change withdrew to the north, these basins became sluggish streams, or filled by the excessive precipitation common in cold regions, temporary lakes. Now this region is underlaid with limestone, stratified and checkered with partings. Rainwater is its solvent. The water would find these partings, and seek discharge by the line of dip of the rocks.

At first, a single drop would find its way, to be followed by others, each enlarging the orifice, until underground brooks were established, wide caverns were opened, and when these became too wide to support the overlying rocks, the roof would fall in and expose the hitherto "lost river." The same process is at work to under-cut the lower fall at Cataract. Wells dug in the valley plain, between Quincy and Cataract, in the old river bed leading to the "flat woods," and in the wide bottoms above Gosport, indicate beds of laminated sand and muck of lacustral character.

The foregoing presumption, referring the deeply excavated valleys of Fish, Lick and Rattlesnake creeks, and the "flat woods" channel of White river to the agency of glacial ice water, is reasonable and founded upon the facts incidentally mentioned, but fully confirmed by the trail of small, white, quartz pebbles, black sand (magnetite), and gold dust found along these streams. Objects which here, can only be attributed to the imported rocks of the

ALLUVIUM.

The alluvial bottoms bordering the streams are due to causes now in action. As rocks are pulverized by action of the atmosphere, by the frost or heat of the sun, or by the abrasion, pounding and rolling of the brooks and streams, the fine residuum is seized by currents and thrown down by the still water on their flood plains. Combining all the minerals utilized by plants, they are very fertile, rivaling the stories of Egypt in the perfection and abundance of their products. Common crops are grown to advantage—the yield of corn is simply enormous.

PALEOZOIC GEOLOGY.

The rocky formations of Owen county belong wholly to the Carboniferous age, and comprise that part of the coal measures beginning at Coal K, reaching down to the bottom of that group, and through the upper part of the Sub-carboniferous to the top of the Knobstone beds. The highest geologically of these strata are found at

the western line of the county, near Coal City; the lowest in the bed of White river above Gosport, the whole tabulated from isolated outcrops, gives the following exhibit:

GENERAL SECTION OF OWEN COUNTY.

CARBONIFEROUS AGE, CARBONIFEROUS PERIOD.

Coal Measure Group.

		Ft.		Ft.	In.
1.	Surface drift and soil	0	to	110	00
2.	Brown ferruginous sandstone	12	to	4	00
3.	Black sheety slate and sandstone			3	06
4.	COAL K	1	to	2	06
5.	Fire clay			3	00
6.	Gray shale and slaty limestone	12	to	19	00
7.	COAL J, (part block)	1	to	4	02
8.	Laminated under clay	2	to	6	00
9.	Clay shale and shaly sandstone	18	to	12	00
10.	COAL I, block	2	to	6	07
11.	Laminated under-clay	2	to	7	00
12.	Siliceous shale, locally rich in nodular iron ore, passing into sandstone	14	to	8	00
13.	COAL B, part splinty cannel	½	to	3	02
14.	Fire clay	2	to	4	00
15.	Clay shale or sandstone	8	to	13	00
16.	Coarse soft sandstone, glass stone	15	to	4	00
17.	Massive conglomerate, grit stones	60	to	90	00
18.	Black aluminous, pyritous shale, locally with bands and nodules of clay ironstones	0	to	20	00
19.	Black shale	2	to	00	00
20.	COAL A, caking, impure	0	to	1	06
21.	Fire clay	4	to	2	00
22.	Dark pyritous shale, with ironstone nodules passing into sandstone	40	to	10	00

SUB-CARBONIFEROUS PERIOD.

Chester Group.

		Ft.		Ft.	In.
23.	Kaskaskia limestone	15	to	22	05
24.	Dark silicious shale	10	to	5	00
25.	Chester sandstone, laminated, ferruginous, with locally white quarry and grit beds	60	to	80	00

St. Louis Group.

26.	St. Louis limestone, laminated, concretionary, or in heavy strata..................	90	to	70	00
27.	"*White quarry stone,*" Warsaw ?.............	2	to	30	00
27*a*.	Gray limestone interchanging with sandstone....................................	12	to	6	00

Keokuk Group.

28.	Keokuk beds—hard gray or buff limestone—with intercalations of indurated clay, containing geodes............	50	to	46	00
29.	Blue shale and aluminous limestone (*Burlington beds?*)...........................	10	to	5	00

Knobstone Group.

30.	Coarse ferruginous sandstone................	5	to	10	00
31.	Gray shale and argillaceous sandstone, disintegrating	40	to	25	00
	Total exposure of rocks			682	00

DESCRIPTION OF THE GENERAL SECTION.

COAL MEASURE PERIOD.

Coal Measures.

The coal measures, including the conglomerate sandstone, occupy a large area in the western and southern part of the county. The conglomerate is well developed on each side of Eel river, in the northwest part of the county, (although the floor and the foot bluffs of the river are of subcarboniferous limestone), it trends east to Fender hill, south of Cataract, then bending west and south, it is the surface rock on the west bluff of Rattlesnake, crosses White river near Freedom, and is found covering the hills and elevated areas in the southeastern part of the county. They are designated by Nos. 1 to 22 inclusive, in the section. Outliers, of small extent, (their companion beds eroded during the glacial period), are found east of the line above indicated, and considerable exposures of the Chester beds, especially the Kaskaskia limestone, are found in the deeply cut valleys to the west of this line.

Coal K, number 4 of the section, is generally absent,

two outcrops only being noted, one north of Coal City, near the county line, the other southeast of the same place on the farm of White, section 14, township 9, range 6. The seam is irregular and unreliable, varying from a few inches to two feet. The coal is fat, sulphurous, coking, and burns with much cinder to a red ash. In the black, sheety slate roof were noted fish remains, as bones, coprolites, and spines and plated scales of *Petrodus occidentalis*. The overlying limestone is argillaceous and bituminous, consequently not of much economic importance; it contains *Spirifer cameratus*, *Spirifer lineatus*, *Athyris subtilita*, *Productus costatus*, *P. semireticulatus*, *P. longispinus*, *P. cora* and *Lophophyllum proliferum*. Coals J and I, Nos. 7 and 10 of section, are of a laminated or splinty structure, characteristic of our block coal, with, at localities in the western parts, one or more partings of fat, resinous, splinty cannel. They occupy an area of about 45 square miles in townships 9 and 10, in ranges 5 and 6. This area was a great depression in the bed of the carboniferous ocean, walled by a shore or bluff line of conglomerate sandstone to the north and south, a bay or gulph opening into the grand carboniferous sea to the west. In this quiet bay or lagoon, protected from wind and wave by bold promontories to the north and south, was macerated and pulpified (a process necessary to manufacture block and cannel coals), the vegetable material which now constitutes J and I; block coals, from their nature are not persistent over large areas, but here they are fortunately more regular than in the most favored fields.

When the surface is uneven or hilly, a very considerable amount of these coals has been removed by denudation and erosion.

The underclays of J and I, as far as seen, are laminated or shaly, indicating a subaqueous deposit, rather than the soil which produced the plants to form the coal.

Coal J, although laminated, contains so much volatile matter, as splinty cannel, etc., that in the mere local market it is neglected, and but few opportunities of investigation

afforded. The upper coals north, south and west of Coal City are referred to this seam.

Coal I is generally developed around Patricksburg and thence west, south and southwest, to within two miles of that corner of the county. It is a splendid block coal, burning with little smoke or cinder, like hickory wood, to a white ash. It varies from three to nearly seven feet in thickness, and although at a few localities it contains partings of splinty cannel, it is eminently a free burning block coal, generally free from sulphur and other impurities, and believed to be well suited for the blast furnace, in the natural state. It is an excellent fuel for steam, rolling mill, glass factory, household and locomotive use.

Coal B, No. 13 of section, lies from 12 to 20 feet below coal I, and is seen in outcrops all around the northern, eastern and southern rim of the latter. It is also found at intermediate valley stations where coal I has been eroded and washed away. B is typically a fat, gassy coal, but generally comprises one or more divisions of resinous, splinty cannel, almost as rich and pure as Albertite. The best developed view of this seam is at the Arney and the Needy mines, section 9, township 9, range 5. At other points, north and northeast of Patricksburg, this coal, although thin, is remarkably pure, pure enough for gas making, and at a few stations presents a rare article of cannel coal.

No. 16, the upper coarse, soft member of the conglomerate, is incoherent or readily disintegrates, becoming a mass of coarse sand. On exposure, the iron it contains is dissolved and carried away by rainwater, leaving the leached residue clean and white, suitable for glass making. A fine deposit was noticed southeast of Patricksburg, on the Vandalia road.

CONGLOMERATE SANDSTONE.

The massive Conglomerate, No. 17 of section, develops a broad band from three to six miles, reaching across the county from northwest to southeast corners. Although eroded and cut through by the streams, so as to expose the underlying limestones, etc., in many of the creek valleys, it

is the general surface rock, the valleys excepted, in all the region north and west of Cataract, in the space between Rattlesnake and Fish creek, and in a strip from two to three miles wide along the southern boundary of the county. This stone is either heavy-bedded or massive, splits readily, dresses well for hammered masonry, hardens on exposure, is fire and water-proof, and is a superior and desirable material for abutments, foundation and fire-proof edifices. Generally ferruginous and consequently buff or brown in color, at several stations, as at the Moffet farm at the head of Six-mile, at Evans', south of Atkinsonville, and at King's "Buzzard Gulch," section 6, township 10, range 4, good white stone, and superior grits were observed. With facilities for transportation, this stone would be demanded for masonry, and perhaps to an equal amount in value for grindstones and grits.

Coal A, number 20 of section, is a rough, caking coal. It generally contains pyrite, burning with much offensive smoke and yellow flame to a red ash full of clinkers. Besides it is very irregular and inconstant, no where attaining a thickness of over two feet in the rare pockets, the average for the whole area would not probably exceed five inches. The returns gathered in mining A will not likely exceed twenty cents on the dollar expended.

The dark or black aluminous shales Nos. 18 and 22 are pretty constant companions to coal A, in fact, more certainly persistent than the coal itself. At several points they carry considerable bands and beds of clay ironstone, but are more notable for the amount of pyrites generally contained. This decomposes on exposure to air, undermining the superimposed conglomerate, and forming cavities and "rock houses."

The life of the carboniferous age was peculiar. A curious vegetation prevailed, so exuberant as to amass vast beds which stored the sunlight and heat of the past for to-day's use. A majority of these remains are referred to in the books as land plants: *Ferns, Lepidodendrons, Sigillaria, Stigmaria,*

Calamites, etc. Many algæ are seen as *Chondrites*, *Caulerpites*, and a tender vermiform fucoid, not sufficiently preserved for determination. The animal life is wholly marine, ranging in habitat from the shore zone of 50 to 100 feet down, to the shell fishes, etc., whose home was in the vast depths of the mighty sea. Air breathers are rare or entirely absent, no evidence of such were seen in this county.

SUB-CARBONIFEROUS PERIOD.

Chester Group.

The Kaskaskia limestone, No. 23 of section, is the upper member of the Chester group. It heralds a great change in the conditions, life and results of the earth's existence. Here a line is drawn by the fossils, sharp and distinct. In this bed and below, a peculiar marine life, animal and vegetable, flourished in profusion, with but few evidences of any dry land. Most of this life perishes and becomes extinct. A few survivors, a meagre minority, live over in the coal measure epoch. They were replaced with new forms. A new life was introduced, antieipating the needs of to-day.

The Kaskaskia only exhibits a thickness of from five to twenty-two feet, is a marked horizon, easily recognized, drawing the exact line above which coal may be found and below which it is not found in workable deposits, hence its significance and economic importance as a geologic index.

This stratum is found well developed high up in the sides of the hill at Jackson's bluff, near Arcola, section 33, township 9, range 4, is just caught in the tops of the hills about Freedom, whence its eastern outcrop bends west on the top of the conglomerate spur near Middletown and Steubenville, when it turns sharply east to Fender's hill near Vandalia, thence north and west to Cataract and the northwest corner of the county. In this rock are found *Pentremites Godonii*, *P. pyriformis*, *P. obesus*, stems of crinoids, probably *Zeacrinus* and *Actinocrinus*, fronds of *Archimedes*, *Zaphrentis spinulosa?*, *Spirifer striatus*, *S. Kentuckensis*, *Athyris ambigua*, *Productus punctatus*, *P. semireticulatus*,

Retzia vera?, *Rhynchonella Osagensis*, *Pinna* (?), *Hemipronites crenistria*, and teeth of fishes. Generally these fossils are fragmentary, or in poor preservation, but distinct enough for identification. The stone breaks irregularly, containing some argillaceous matter, weathers brown or buff, and is only tolerably durable, though hard to work. It is used for rough foundations and for burning. It yields a dark, strong, "cold" lime. When highly ferruginous it decomposes, forming extensive beds of red and yellow ochre, as at Stiltz farm, north of Middletown, and at Sloo's, section 19, township 9, range 5.

The Chester sandstone, No. 25, succeeds below. It is from 60 to 80 feet thick, generally ferruginous and closely laminated; at several stations it affords good quarry stone, easily wrought. The fossils are rare, comprising a few plants, as *Lepidodrendon*, *Sigillaria*, *Cordaites* and *Fucoides*.

ST. LOUIS LIMESTONE.

The St. Louis limestone, No. 26 of section, lies immediately below the Chester sandstone and outcrops in a broad belt from two to four miles wide, with axis extending from Quincy, southeast by Mill creek and McCormack creek, to the eastern boundary of the county. It is typically a thin, heavy bedded limestone, often concretionary or argillaceous, sometimes dark colored from disseminated iron, with partings of indurated clay containing a small amount of magnesia. The upper division at several stations is in thin laminæ, and affords paving stones as at Fletcher's quarry, near the mouth of Rattlesnake and Mill's quarry on Mill creek, or where the layers are thicker, excellent rubble stone as at Schweitzer's quarry, near Spencer. In the same beds is found a fair lithographic stone, which can be furnished by the car load, and has been used by lithographers for "transfers" with good results. Large quantities may be obtained at the last mentioned locality, as at many other stations. Just outside, or last of the axial line of this bed is the "White quarry stone," division No. 27 of the St. Louis limestones, sometimes known as the Warsaw limestone.

It is amass of crushed shells and other animal remains, deposited in a trough or depression in the floor of the ancient ocean, from a half to one and a half miles wide, which may be traced in south and southeasterly directions almost continuously, by Ellettsville, Bloomington, Bedford to Salem, in Washington county, and perhaps further. At favorable exposures, the Keokuk beds are seen depressed beneath this trough, rising above, (notwithstanding the dip), at the west as well as eastern margin, thus forming a depression in which the light shells, etc., would be drifted by slight currents. Here are entombed the remains of billions of individuals to the acre. The animals are small, some microscopic. The stone is compact, fine grained and pure, in proportion to the degree of comminution to which these remains were subjected. The quarry stone is a white or gray neutral tint, may be quarried in blocks of any size demanded, saws well, is tough under the chisel, capable of resisting great weight, resists the action of the elements well and, in fact, combines all the points of a superior building stone. It has been used in many of the public edifices of our western cities, and is everywhere favorably known. This division (quarry stone) is irregular, varying from 2 to 30 feet in thickness, and sometimes thins out to a mere parting. The animal life of the St. Louis limestone was wholly marine, and consisted generally of animals that occupied the zone of cool or temperate pure water, from about 600 to several thousand feet in depth. The characteristic fossil is *Lithostrotion*, but three specimens *L. Canadense* were seen; *L. Proliferum* was common, sometimes in open clusters, the calyces were generally solitary and of extraordinary size. Some specimens from 5 to 9 inches in length, and from one half inch to one and a quarter inches in diameter, also, *Productus punctatus*, *P. cora*, *Athyris ambigua*, *Spirifer striatus*, *S. Keokuk? S. Leidii*, fronds of *Archimedes Owenena*, *Aulopora gigas*, *Pentremites conoideus*, and fragments of *P. Woodmani*, stems of crinoids but no heads. Spines of *Archæocidaris*, *Rhynchonella sub-cuneata*,

Retzia vera, R (*Sp.?*). *Terebratula hastata, Hemipronites crenistria, Platyceras acutirostris, Bellerophon, Straparollus, Conularia,* and *Rotalia Baileyi.* Teeth of the great sharks *Helodus, Cochliodus, Deltodus* and *Cladodus* were rarely seen. A good fossil bed was noted at stone-cut, near Cave-Spring station, on the New Albany & Chicago railway.

KEOKUK GROUPS.

The Keokuk beds, No. 28, succeed next in age and inferior position. They are first seen near high-water line at the foot of the hill at the pork-house near Spencer; above town they descend to low water, passing under the quarry depression of the St. Louis limestone, from thence they continually ascend to the northeast, passing well up on the hillside as Gosport and out at the surface in the northeast corner of the county. They consist of heavy bedded, dark or gray colored, hard, rough limestone, with intercolated beds of clay, often filled with geodes or partings of chert. The geodes are characteristic and an interesting feature. Rough and uncouth outwardly, they are filled with nature's brightest, purest gems, and freshly broken, sparkle with the imprisoned light of past ages.

This limestone is used for foundations, steps, curbing, rip-raps and walls exposed to rapid currents of water. It is sometimes burned for lime, but is generally too ferruginous. A farm wall of this stone was neat, effective and permanent. Life was abundant. Crinoid stems crowd the rocks, and although heads of these animals were rare, it was evident that they filled the sea with their singular forms. Close investigation will yet discover good crinoid beds. Stems and broken fragments were seen of *Actinocrinus* and *Goniasteroidocrinus*, spines of *Archæocidaris*, plates of *Melonites* with *Pentremites Worthenii, Platyceras fissurella, Spirifer Keokuk, Spirifer striatus, S. cuspidatus, S. neglectus, S. lineatus, S. pseudolineatus, Retzia Verneuilana, Rhynchonella subcuneata, Terebratula trinuclea, Bellerophon sub-lævis, Dentalium primevum, Hemipronites*

crenistria, *Zaphrentis Dalyii*, *Archimides Owenana*, and *Aulopora gigas*.

In the blue argillaceous stone below No. 29, which may possibly represent the Burlington beds, were noticed in the railroad cut at Gosport, *Spirifer plenus?*, *S. striatus*, *Productus semi-reticulatus*, *Chenetes planumbonum*, *Aviculopecten amplus*, *Hemipronites crenistria* and *Fucoides*.

The life of this period is still marine. No sign of aerial life or dry land was seen. The animals required tolerably pure water, and a depth of from about 500 to 3000 feet. At adjoining stations are found *Spirifera*, *Athyris* and *Producti*, of a type heralding the approaching age of coal.

THE KNOBSTONE GROUP.

This bed, No. 30 of section, is seen below the New Albany railroad, and thence ascends to near the top of the hills in the northeast corner of the county, and gives character and shape to some of the sharp, mound-like knobs in that region. The impure water and muddy bottom of the sea at this period was not favorable for the life of water-breathing animals, nor for the preservation of their remains. No sign of life was seen, except a vermiform fucoid, which was common.

The upper division generally affords quarry sandstone of fair quality, but here none was seen of economic importance. The shales contain much pyrites, which, decomposing on exposure, give cause for chalybeate and sulphur springs.

LOCAL DETAILS.

The rocks of Owen county have a general dip, varied locally, of from 30 to 50 feet to the mile, and averaging in the sub-carboniferous about 33 feet per mile, in a direction west southwest. This explains the continuous disappearance of strata going west, and the occupancy of the surface by rocks of a higher position geologically, and more recent age, but actually at a lower level. The outcrops, in view from the west side to the northeast corner of the county,

are equivalent to a bore or shaft put down, in the valley west of Patricksburg to a depth of nearly 700 feet.

The occurrence of Knob sandstone and shales near Alaska, in the northeast corner of the county, is already mentioned. Here the ridges and tops of the hills are capped with limestone of the Keokuk group, which is soon carried by the dip to the bluffs and beds of the ravines and brooks.

Quincy is situated in an extensive valley known as the "flat woods," which dates back to the glacial age, and extends from Cataract in a northeasterly direction to Morgan county, and beyond. Here the ice foot rested for a long time against high ridges of limestone to the south, and melting, sent their waters to the south and west by Rattlesnake and Jordan. The pounding, washing, grinding process, resulted in an excavation much lower than the then outlet, and as the ice retired north, the excavation for a time became one of our ancient lakes. Wells to the number of 8 or ten in the village, at a depth of 25 or 30 feet, pierce a black, mucky soil, containing brush, trees, leaves, grass, etc. This unctuous clay is characteristically lacustral. It is underlaid with quicksand, and fine glacial gravel. The valley plain produces fair crops of corn and wheat, but is better suited for meadow grasses, of which good returns are received. The soil of the surrounding ridges is a rich yellow limestone clay, admirably adapted for the growth of wheat, clover and blue grass. It was originally clothed with a grand forest of sugar, poplar and walnut trees. One of the wells in the village gave the following exhibit:

SECTION IN QUINCY WELL.

	Ft.	In.
Black soil	1	08
White and gray clay, with crawfish pipes, with little sand—no pebbles	10	00
Blue clay, with pebbles	3	00
Black mucky clay, with brush aud plant remains	3	00
Hard pan and fine pebbles	3	00
Coarse gravel and boulders, (depth unknown)	3	00
	23	08

The trunks found in the above were of trees 4 to 5 inches in diameter, generally crushed or broken to pieces. The insertion of the branches was opposite and alternate, like fir or ash, and the rings of growth were compressed and fine, as if subject to a cold climate.

"Stone cut," on L. N. A. and C. R. R., a mile north of Cave Spring station, exposes an outlier of the lower division of the St. Louis, rich in characteristic fossils, and worthy the attention of students. The bottom of the cut contained Keokuk fossils.

The soil in this vicinity, formed from decomposition of limestone, is rich and productive. It was covered with a magnificent growth of walnut, poplar, oak, beech and sugar trees. Some giant specimens still survive. A poplar was measured 20 feet and 8 inches in circumference, with trunk 65 feet long. The farmers are prosperous and thrifty, as indicated by good houses and barns, and well appointed farms. Much attention is given to grazing and the cultivation of blue grass. "Sink holes" abound, showing the cavernous nature of the rock below. These funnels collect the rainfall which is carried by underground streams to a favorable outlet.

Cave Spring, on the farm of Jesse Rogers, near old Middletown, is an example. The spring flows from an open cavern 30 x 40 and 6 feet high, and plunges down a narrow chasm worn in the rock, some 40 feet. It was formerly utilized, driving three buhrs and a carding machine. The water discharge, with a head of three feet, is from 36 to 200 cubic inches, and although now unused, has an estimated capacity, with a turbine wheel, of at least 40 horses for eight months of each year. The temperature of the external air, July 23d, was 92° Fah.; of the cave 71°., in the gulch below the fall the air was oppressively chilly.

SECTION AT CAVE SPRING.

		Ft.	In.
I.	Keokuk limestone crowded with crinoid stems...	20	00
2.	Argillaceous limestone (Burlington?) with suture partings at fossil beds...	22	00
3.	Hard blue limestone in beds of 1 to 2 feet, with fossils, outlet of spring...	7	00
4.	Argillaceous sandstone, geodes and thin plates of limestone...	11	00
5.	Knob sandstone, etc...	25	00
		85	00

Partings between strata were covered with fossils. Some of extra size, as *Hemipronites crenistria*, from 3 to 4⅘ inches long; *Productus costatus* with spines two inches long; also nearly all the characteristic fossils of the group. Eroded spirifers exhibited well their internal structure and spiral appendages. Suture joints—"devil's toe-nails"—were distinct, and showed well their origin from beds of fossils. The cave is 1½ miles east of the station on the railway.

Miller's cave, a mile and a half northeast from the latter, on section 33, township 12, range 2, is surrounded by wild, canyon-like scenery, romantic and interesting. The spring here has a fall of 40 feet, and by a turbine drives a boulder "corncracker" mill. The cavern is 40 feet wide and 4½ to 5 feet high for 100 yards, where there is a long room 7 feet wide and 15 feet high; beyond, the water is deep and the roof descends to within a foot or two of the water. It has been traced, as Mr. Chas. Dow states, more than half a mile to its source in two "sinks," one in Morgan, the other in Owen county. In wet weather the cavern is sometimes filled to its utmost capacity, and the water in the pool is then 25 feet deep. The exposures give the following stratigraphic exhibit;

SECTION AT MILLER'S CAVE.

	Ft.	In.
Keokuk limestone	20	00
Argillaceous limestone, crinoid stems	18	00
Indurated clay, with geodes and long crinoid stems	8	00
Sandstone parting	1	00
Red limestone with *Spirifer striatus*	2	00
Laminated calcareous argillite, with *Spirifer*, *Producta* and *Hemepronites*	6	00
Argillaceous limestone, with geodes	8	00
Knobstone shales and sandstone	10	00
	74	00

On the dividing ridges between and around the sources of these caves, "sinks" from ten to thirty feet deep are very abundant, at some localities averaging one to an acre.

Gosport is a thriving town of considerable commercial importance. It is surrounded by wide alluvial bottoms and fertile uplands, and has the advantage of two railways. The hill, over 100 feet high, on which the town is located, commands a wide view east, southeast and southwest, across and along White river and Bean Blossom valleys. Here White river makes a short bend to the south. A bed of fluviatile sand in the north and west parts of town from 10 to 20 feet in depth, marks the flood plain or high water line of the ancient White river, then flowing 120 feet higher than now. The fair grounds south of town are well situated, and are ornamented with a number of "look-out" mounds 100, 200, 300 and 400 feet in diameter, and 10, 25, 30 and 40 feet high. Their well defined symmetry is striking, no evidence of artificial origin seen except that several quoits and "chungke" rollers were found here. The high conical mound within the enclosure affords a fine view of horse races, etc., at fairs.

The wells in the west part of town pierce sand and red clay, to a white limestone, which becomes shaly or fissile on exposure, in the following order :

SECTION IN GOSPORT WELLS.

	Ft.	Ft.
Fluviatile sand	10 to	20
Red calcareous clay	20 to	10
White fissile limestone	25 to	6
		36

The area covered with sand comprises about 500 acres, shaded by the foliage of trees, etc., it acts like a sponge absorbing and holding the rainfall, the wells are never failing, especially when so protected by vegetation. The top of the ridges and hills west of town are capped with compact gray and white St. Louis limestone, which, when burned, makes a good strong lime; beneath is seen blue Keokuk stone and geodes. The following section, from the top of the hill in town to White river, is full of interest.

SECTION AT GOSPORT.

	Ft.		Ft.	
Slope, sand and red clay	20	to	10	00
White or gray St. Louis limestone			8	00
Green or yellow mudstone, with *Spirifera* and *Hemipronites*			4	00
Brown Keokuk limestone full of crinoid stems, geodes and fragments of crinoidea			20	06
Clay mudstone	1	to	4	06
Gray laminated Keokuk limestone, with geodes small containing calcite, small fossils and many crinoid stems			4	00
Blue argillite (calcareous) with mudstone partings containing large Zaphrentes, Conchifers and Brachiopods	15	to	18	00
Knob sandstone	5	to	12	00
Knobstone shale	30	to	23	00
			104	00

The Knobstone group passes from sight under the Keokuk beds at the foot; the latter pass under the St. Louis at the top of the hill, and the last disappears beneath a covering of Chester sandstone from two to three miles west of Gosport. The blue argillite at the base of the Keokuk beds is possibly "Burlington." It is peppered with minute

geodes, and contains large, broad winged *Spirifers*, *Aviculopecten amplus*, *Hemipronites crenistria*, *Productus semireticulatus*, *P. Cora*, etc. Every marked strata on the hillside signalizes a change in the conditions of the sea, destructive of life, as the partings and beds are universally covered with fossils so perfect that they must have lived and died on the spot. This is often characteristic of the Keokuk beds in this vicinity. The Keokuk limestone is crowded with crinoid stems, but a single head in tolerable preservation was seen, (*Goniasteroidocrinus*). Dip of strata 30 feet per mile to southwest.

A stone fence on the farm of Dr. Smith, one and a half miles north of town, is a novelty in this region. It presents a handsome appearance, cost $2.25 per lineal rod, "is pig tight, horse high, bull strong," and good for 1000 years.

Mr. Fred Goss, a pioneer of 1817, says that on a small hillock or mound, a few hundred yards east of the railway crossing, north of Gosport, a roving band of Shawnee Indians had buried a dead child of the tribe. Shortly after the settlement of Gosport, when the same band was in this region, their chief, "Big Fire," died. They brought his body in a canoe ten miles by river, thence it was carried, by four elders of the tribe, on a bier made of two poles interlaced with bark, to the grave, where it was painted, dressed in his best blanket and beaded moccasins and buried along with his ornaments and war weapons. The grave was three feet deep, lined with rough boards and bark. Over it was planted an oak post, five feet high, eight inches square, tapering to a point at the top, which was painted red. The monument was often visited and long revered by the band. It has disappeared within a few years.

After the departure of the Indians some medical students, who have since become distinguished citizens of our State, determined to resurrect the great Shawnee. Meeting at the mound they proceeded to partially open the grave, when suddenly the report of fire arms and the "war-whoop," given by some festive friends, precipitated an inglorious

departure. Neither darkness, swamp or river, retarded their race, until protected by the Buskirk homestead. They told their story of peril to the great delight of their young friends.

Gosport was founded in 1817. Abram Alexander and Ephraim Goss were proprietors, and with their families were the first settlers in a wilderness surrounded by savages; their nearest neighbor was John Dunn, nearly 10 miles away at Spencer. Among the notables seen in town was Capt. D. V. Buskirk, a representative citizen of our great young State. The captain volunteered for the union during the late rebellion, bore gallantly the march, the battle strife and the the keen tortures of Salisbury prison pens. He is six feet ten inches high, weighs 360 pounds, is active, amiable and kind. He is said to be the largest man in the State—his neighbors emphatically declare that he is the "bigges hearted" man in the world.

Passing south the railway soon enters and cuts across the great belt of "*White quarry limestone*," here enlarged to a width of about two miles; and of which Mill creek is the axis. This bed is a treasure. "There are millions in it.' Immediately on the railway line, easy of access, a stone of the best quality promises to enterprise and labor surer and better returns than Eldorado.

The "white limestone" comes soft from the quarry, work easy and tough, may be quarried in blocks of great size, and combines nearly every good quality of a perfect building material. Some variety is presented passing from soft to hard. The medium compact stone is the best, as it will better bear a burden, and resist atmospheric wear; and at the same time closer in texture, it does not stain as the soft, porous stone will in a smoky atmosphere. The following list comprises a part of the actual or prospective quarries on Mill creek, at Mundy's station, and extending well towards Spencer. They are prepared to fill orders to any amount for rough and sawed building stone, also caps, sills, columns, ashlars, flagging, monument bases, etc., etc.

Rockwell & Co., for the "Eagle Stone works," have opened a massive bed of fine stone just north of Mill creek, and with a short siding, are well prepared to load cars directly from the quarry bed. The stone is compact, well grained and good; and is formed wholly of moderately comminuted shells, Bryozoans, etc. The stratum is fifteen feet thick. Blocks may be obtained of the full thickness of the quarry and thirty or more feet long. They have facilities for shipping from three to five car loads per day.

Adjoining on the south, Smith Johnson has a good deep quarry of similar stone; some beds of light color. Less than one-quarter of a mile northeast, the "quarry bed" thins out and is replaced with argillaceous limerock, underlaid with Keokuk stone.

The "Gosport Stone and Lime Company" have a valuable lease covering the southern bluff of Mill creek, south half, south half, section 3, township 10, range 3. The stone is compact and excellent for chisel work. The quarry was opened in 1874, and a great number of car-loads was shipped for the base of the $250,000 court house at Vincennes. Their switch siding is convenient for loading with the quarry derrick. Higher up the creek is a choice bed of soft white limestone, where at least 5,000 car-loads of stone, quarried by erosion, lies naked. These blocks and masses have been exposed to the elements during the ages since the glacial drift, and thus tested are durable without doubt.

Walter Ring, on southeast quarter of section 33, and southwest quarter of section 34, township 11, range 3, has opened a bed of a peculiar variety of this stone. The bed is 18 feet thick, the lower member compact and close-grained, while the middle and upper strata are soft and chalky white. A chisel, driven by an ordinary mallet, cuts from one-half to three-fourths of an inch at each blow. It is easy of approach by rail along the creek valley, with plenty of sand for sawing and polishing.

M. Hays, on southeast quarter of section 3, and northwest quarter of section 10, town 10, range 3, has an immense

bed of compact stone, of a ruddy or delicate chocolate tint. Exposed by erosion, it is now protected by a slight covering of loose dirt, and to the east presents a mural face, which still retains in bold mouldings the ancient river marks, not obliterated by ages of aerial exposure. This ability to resist disintegration and wear, is conclusive, and is a sufficient indication. With a switch along the face of the bluff, this stone can be quarried with very little expense in unlimited quantities. It is especially recommended for rough building stone in which cheapness is a ruling element. The "White River Lime and Stone Company," Simpson & Archer, proprietors, of Spencer, have a well appointed quarry on southeast quarter, northwest quarter, section 10, township 10, range 3, at Mundy's Station. They are prepared to fill wholesale or retail orders in sawed or dimension stone, monumental bases, spirals, lime, etc. Their quarry face gave the following exhibit:

SECTION IN WHITE RIVER CO.'S QUARRY.

	Ft.	In.
Soil	1	06
Laminated stone, for burning	10	00
Gray rubble and bridge stone	4	02
Upper sawing band, for bases, etc	3	09
White sawing stone	16	03
Total quarry bed	34	08

The upper stratum has been burnt for lime with profit. It yields a snow white lime, slakes slow, does not set too quick, and works cool. All refuse of the quarry may be burned, so that no waste of stone or labor is necessary. The quarry bed may be broken with wedges to any shape desired, and so true that little or no dressing is required for foundations. As large blocks can be furnished as may be transported by rail; and, in fact, larger, for columns can be had 4 x 6 feet, 20 or more feet long. Slabs were seen on the yard with face 9½ x 6 feet and 5 inches thick, sawed true and correctly. It works tough under hammer and chisel, and is desired for capitals, mouldings and ornamental

work. Specimens may be seen at the Court House, Pennsylvania street hotel, etc., at Indianapolis, and many of the finest buildings in the west. The stone weighs 150 pounds per cubic foot; capacity of derrick, 150 feet, or one car load. The works are driven by a steam engine of 40-horses with power of pushing eight gangs of from one to ten saws, with a dimension capacity of 15 x 42 face, and 2 to 8 inches in thickness; daily cut of saws, 24 inches, or 2 inches per hour. Sales amount to $1000 per month—expense for labor, $450, leaving for wear, tear, interest and profit, $550 per month. They began in 1870 with a capital of $500; have since exhausted one-fifth of an acre, and sold products amounting to over $40,000. Their switch receives stone from the mill and quarry derrick, and delivers coal at the furnace door. To supply the mill a well was put down in the valley, which proved that this narrow chasm, unconnected with any extensive water-shed, had in glacial times been eroded as low as the present bed of White river.

Along the Indianapolis & Vincennes railroad track, immediately sonth, Messrs. Ellis, Judge W. M. Franklin, R. M. Beem and B. Schweitzer have each quarries varying but little in quality, but each having some special point in its favor. They are all well situated, and have first-class facilities for mining and shipping excellent stone. The hill at Beem's and generally the highest ridge is capped with Chester sandstone.

Spencer, the county seat, is pleasantly situated upon a slight terrace, overlooking the alluvial bottoms of White river. It is noted for its solid prosperity, fine school house, orderly children, and the universal love and cultivation of flowers. The citizens are justly proud of their neat, substantial and even elegant graded school building. The edifice will bear favorable comparison with any in our cities, and although crowded with children of all ages, its walls did not show one mark of defacement. The teachers certainly deserve much credit—the children more. Superintendents throughout the State could well strive to copy the model here offered. The grounds are tastefully adorned

with shrubs, flowers, etc., planted and cultivated by willing boys and girls, who are joint owners.

The hills north, west and south of town are built up with St. Louis limestone, generally argillaceous, and capped with Chester sandstone. The pork-house, a mile west of town, is a large stone building, with the best modern fixtures for the preparation and cure of meat. The establishment was neat, clean, and in model condition. A bold bluff to the south gives the following:

SECTION AT SPENCER PORK-HOUSE.

	Ft.		Ft.	In.
Chester sandstone	20	to	0	00
Slope on ridge			40	00
Soil, stripped			5	00
Rubble stone, laminated argillaceous limestone, part lithographic			38	00
Siliceous fine stone, passing into cherty limestone			14	00
Fossil limestone			5	00
Siliceous mud stone			6	00
White limestone, used for burning	4	to	10	00
Concretionary limestone, with flints and sandstone	18	to	7	00
Covered Keokuk beds to river			31	00
			156	00

Bernhardt Schweitzer's stone and lime quarry is on adjoining land northwest quarter section 29, township 10, range 3. The quarry stone is an argillaceous limestone, in layers 2, 4, 6, 8, 10, 12 and 14 inches thick. A film of clay allows the rock to come up freely presenting smooth faces; the layers are usually persistant; but with sledges are easily broken in square or oblong blocks of dimensions suited for the purpose intended. With skill the fracture is nearly at right angles to the plane of stratification. Fixtures are adequate to the loading of 6 to 12 cars a day. Shipments in 1873 were 600 car loads at $10.00; in 1874, 400 car loads at $8.00 per load. This material known to the trade as Schweitzer's "*Rubble stone,*" is used for foundations, water tables, etc., at Indianapolis, Vincennes, etc., being

ready for use without expense of dressing, it commands favor and a ready market.

Lithographic stone is present in the same quarry, in layers from 2 to 4 inches thick. For certain work it answers a good purpose, but the demand is limited, about $400 worth have been sold for this use. In the quarry are found a few fossils common at the junction of the St. Louis with the Chester, viz: *Productus cora, Zaphrentis spinulosa, Athyris sub-quadrata, Hemipronites crenistria, Bellerophon laevis*, etc. On the same tract is a bed of gray limestone, which Mr. S. burns, 6 to 10 feet thick. He uses a "perpetual kiln," 35 feet high, 12 feet in diameter, with capacity for one car load per day, or 1800 bushels per week. The stone burns readily and even, slacks complete, works cool, and without "specks or blister." The lime business is profitable, and the excellent material in the county ought to be marketed with good returns. Mr. S. has experimented with hydraulic cement, mixing refuse lime with argillaceous material abundantly at hand. Results offer him encouragement. In the same hill, is an outcrop of refractory siliceous stone closely laminated, known as "Fire stone," it resists the action of heat, and is sought for lining furnaces, fire-places, etc.

On the farm of J. W. Archer, southeast quarter section 18, township 10, range 3, northwest of town, is a bed of creamy white St. Louis limestone, somewhat laminated, but would doubtless prove an excellent material for doorsteps and other uses subject to wear. A polished specimen showed a close grained, compact texture. It would probably burn to a very white lime. On this farm and along the ridge west of town are seen outcrops of Chester sandstone, while the deep valleys are built up with St. Louis limestone.

On the bluff north of town and in the road half a mile above the narrows, slabs were seen covered with long, slender, solitary calyces of *Lithostrotion proliferum*, etc. Black sand at this locality, seen in the wet weather washes, is a foot mark of the glacial age, black magnetite, imported from the extreme north, and which, by reason of nearly

equal specific gravity, is so constantly associated with gold dust brought hither in the boulders, etc., on the glaciers.

Four miles south of Spencer, and east of the river, the valley suddenly widens from a half to about two miles. Within are two interesting island mounds, around and between which, in former ages, the river has evidently had channel, while from the east, sand and gravel more than 100 feet upon the hills, indicate a former discharge of water from that direction by a wide valley, which now guards a little brook. This is an interesting specimen of erosive action. A detached mass of stone on the west of the mound is known as "Big Rock." Thirty years ago it was the location of a floating grist mill, which when anchored, was driven by the passing current of the river.

At McCormack and Rocky creek, a few miles above Spencer, on the east side of White river, are well developed and extensive beds of "White quarry limestone." The latter locality has been well tested by Prindle & Hays, who exhibited some specimens highly polished and of marked beauty from a "marble" ledge at the top. This stone is fine and close-grained, of a creamy white color, and compares favorably with any in the State. Their quarry, northeast quarter, northwest quarter, section 22, township 10, range 3, gives the following structure:

SECTION AT PRINDLE & HAY'S QUARRY.

	Ft.	In.
Slope.		
White foundation stone	6	00
White "marble" stone	4	00
Choice white, extra good	6	01
White sawing stone	4	06
Good gray sawing stone	3	10
Base, sometimes coarse and ruddy, for dimension work	4	07
	29	00

This stone is believed to be fully equal to that at the quarries on the opposite side of the river, as there, it is composed wholly of the remains of marine animals, broken,

crushed and ground to dust—the coral dust of the sea, and re-cemented by nature. In proportion to the degree of comminution, the stone is fine, close-grained and white. When the shells are broken and only partly crushed, the stone is apt to be colored and porous. Soft and tough from the quarry, it hardens in the air, and bleaches to an agreeable neutral tint. The rounded face of the bluff, corrugated by water-lines of ages, show its enduring quality. There are more than 1000 car loads stripped by nature, inviting attention, which could be split and loaded with little expense if a track-way was laid across the river and up the creek valley. A short distance above the mouth the stone is thickened up to 32 feet. It soon thins again, and within a mile is lost and replaced with argillaceous, concretionary limestone, in heavy strata. Plant remains are seen in the "quarry beds." Occasionally a cone or leaf of *Lepidodrendron* is uncovered and wakes from its stony trance to tell a single word of the dry land which overlooked the silent, sub-carboniferous sea.

In northeast quarter, section 23, township 10, range 3, the creek passes through a gorge only 100 feet wide, and impinging against the northern bank, affords the following exposure:

SECTION AT HIGH BLUFFS, McCORMACK CREEK.

	Ft.	In.
Heavy bedded buff limestone, with *L. proliferum*, *Syringapora*, and *Sponges*	25	00
Laminated argillaceous stone	20	00
Hydraulic stone, concretionary, argillaceous	27	00
Massive limestone	9	00
Blue shale	4	00
Banded concretionary limestone	14	00
Flaggy limestone, in bed of creek	10 to 2	00
	101	00

Springs seeping from crevices in the rock, or springing from the summit, cool the air and reach the bottom in a cloud of spray, the wild, romantic scenery, reverberating roar of falling water, cool air breathed by the cavernous

rocks, renders the valley a favorite picnic ground, while disciples of Walton are greeted by their finny friends. Still ascending the creek, a wild, rattling roar, intensified by quick, sharp echoes, shakes the air, confusing the mind by its overwhelming ubiquity. The falls would be insignificant in a wider valley, but in this narrow canyon it is full of never tiring interest. The following section is exposed:

SECTION AT FALLS AT M'CORMACK CREEK.

	Ft.	In.
Hard thick bedded limestone, to slope	8	00
Cherty argillaceous limestone, with *Lithostrotion*	5	00
Argillaceous limestone, with chert balls	14	00
Hydraulic clay stone	7	00
	34	00

On slabs worn by the hurried current, were noticed solitary specimens of *Lithostrotion proliferum*, generally one-quarter to one-third of an inch in diameter, and 2 to 4 inches long, two specimens were seen 8 to 11 inches long and three-quarters to one and a quarter in diameter. They were giants of their race.

Above the mouth of McCormack creek, the bottoms of White river are from one to two miles wide with bluffs, rounded or gently sloping to the plain, but a short distance below the mouth of the "narrows," the bluffs 150 to 180 feet high, suddenly approach with precipitous or overhanging faces and reduce the valley to a mere gorge, indicating a recent cut not yet widened and rounded by water and time. Terraces are discovered on either side of the upper river, 140 to 150 feet above its present bed, fluviatile drift. Where did this water flow before the chasm at the narrows was opened? Proceeding up McCormack creek, the mystery is solved. Beyond the falls, a broad valley from one to two miles wide, 130 feet above the present channel of White river is found, walled with rounded or sloping ancient bluffs, and passing near the west line of the county, returns by Raccoon creek to the wide river valley below Freedom. No intervening ridge exists having a summit

level of more than 140 feet above the river. Along this ancient river bed imported glacial gravel was seen, and on Raccoon some fossils peculiar to Brown county, indicating that for a time Bean Blossom had discharge by a depression said to exist in the rim of the basin, directly from Ellettsville through this trough known as the "Flat woods." The soil of this valley-flat is a yellow loam, evidently made by a sluggish stream, or lake. The underground quicksand and black silt seems to be lacustral. Mr. W. J. Walden gives a statement of material found in a well on his farm, southeast quarter of section 26, township 10, range 3, showing the nature of the Flat woods subsoil.

SECTION IN "FLAT WOODS."

	Ft.	In.
Black mucky soil	8	00
Sand and fine gravel	6	00
Jelly-like, blue, sticky quicksand, with logs, sticks, leaves, etc., no bottom found with iron rod	8	00
	22	00

Going south down this valley, on a bluff hill 250 feet above White river and 120 feet higher than this basin, rough boulders, and beds of Chester sandstone in place were seen. Southwest quarter of section 12, township 9, range 3, near this, a "silver mine" was attempted by clearing out an old sink, (used as a cache by the Indians), and blasting down into the St. Louis limestone; it is jocularly known as "Schweitzer's folly." No silver or other valuable metal can be found here.

Paving stones apparently of fair quality were noticed at Mill's quarry on Wyatt creek, and on Little Raccoon, west of White Hall. They are siliceous, seemingly abundant, and will prove valuable.

SECTION ON RACCOON.

PAVING STONES.	Ft.	In.
Slope.		
Dark cherty limestone	22	00
Fire-proof paving stones, flags	18	00
Argillaceous L. S. to brook	35	00
	75	00

White Hall is a quiet village nestled in a valley. St. Louis limestone is seen in the deepest ravines, the sides of the hills are built up with Chester sandstone, and the knobs are capped with conglomerate. In the valley basin northwest of town, in the neighborhood of J. Rone and W. Coffey, are many "sink-holes," some of which are known as "breathers," giving discharge to water and currants of cold air; others are called "drinkers," receiving the rain-fall. On Coffey's farm, section 22, township 9, range 3, several of the latter were seen, and rippling brooks could be heard in their dark course in the cavernous earth. Small specimens of kaolin clay have been found near to the west of Coffey's; also choice specimens of oolitic limestone.

At Green's mill, on Big Raccoon, the stream has cut a deep, narrow channel. The cliff opposite is beautifully clothed with evergreen hemlocks and cedars. The following section was observed:

SECTION OF GREEN'S MILL.

	Ft.	In.
Chester sandstone, with diagonal false bedding.......	47	00
Slaty pudding stone..	4	00
Fossil lithographic stone....................................	16	00
Flaggy firestone, (siliceous)................................	10	00
	77	00

Some interesting stone cooking vessels were found hid in a cavity of this bluff, including a pot having a capacity of three gallons, and a skillet for baking tortillas, (hoe-cakes). Some time and money has been unwisely spent here in search of silver; it was found to be a very "barren ideality." The precious metals cannot be found here. A mile and a half northwest from Green's mill, a small brook, tributary to Raccoon, has undercut a ledge of stone, forming a natural bridge, reported to be 22 feet long, 18 feet high and 10 feet wide. The elevated region for miles north towards Spencer, exhibits a good soil, and most favorable location for fruit. Several profitable orchards were noticed. W. Y. Mills has an orchard in successful bearing which comprises 500 trees of choice varieties.

At Arcola coal A has been opened one foot thick—it is not worth working. The Kaskaskia limestone is seen in the creek north of the village. R. H. Gentry found near here, buried in the ground, edges up, five new sharp stone axes, grooved for handles, laid away for future use and buried, perhaps, to retain the tough elasticity of the stone.

At "Jackson's Bluff," land of J. and D. Prewet, the Kaskaskia limestone was formerly burned for shipment by boats on White river. In a thin outcrop of coal A specimens of choice cannel coal were found, it is thin, and of little economic value. The limestone is well developed and contains well preserved characteristic fossils.

SECTION AT DYER'S HILL.

(Southeast quarter, section 33, township 9, range 4.)

	Ft.	In.
Conglomerate sandstone	25	00
Coal and shale		04
Kaskaskia limestone	19	00
Shale and Chester limestone	55	00
	99	04

SECTION AT JACKSON'S BLUFF.

(Southwest quarter section 33, township 9, range 4.)

	Ft.	In.
Slope	40 to 20	00
Laminated conglomerate	8	00
Coal parting		04
Massive conglomerate	12	00
Shale and cannel coal	1	08
Kaskaskia limestone	18	00
Shale and Chester sandstone	70	00
	130	00

Mt. Pisgah is a prominent outlook commanding the great valleys which radiate from it. Houses across the valley on the conglomerate hills to the south, shrink to mere specks in the distance.

Interesting to the geologist is the trip by rail from Spencer by Freedom to Schweitzer's shaft, two miles beyond

the line, in Greene county. The railroad track at Spencer pork-house rests on the upper strata of the Keokuk group, which thence south is no more seen. The hill is built up 97 feet with St. Louis formation, and Chester sandstone is just caught in the top of the hill. Going down the river, the road is down grade; we actually descend, but geologically, rapidly ascend to higher rocks. The dip to southwest carries the St. Louis under the track half a mile below the crossing of Rattlesnake, and the Chester beds from the bluff, presenting some good quarry sandstone, with the Kaskaskia limestone at the summit.

SECTION AT FREEDOM.

(Ritter's Hill, southeast quarter section 20, township 9, range 4.)

	Ft.	In.
Surface soil etc......10 ft to	30	00
Soft conglomerate......	25	00
Massive conglomerate......	30	00
Place of coal A......	1	00
Kaskaskia limestone......	22	00
Chester ferruginous sandstone......	60	00
Chester sandstone, massive in river......	19	00
	186	00

A short distance west and south of town, conglomerate sandstone forms the tops of the hills, and several quarries were noted of superior white sandrock and grit stone. That on Mrs. Devore's land, northeast quarter, section 17, township 9, range 4, was visited. The upper beds of the Chester group rapidly dip to southwest, soon approach the railroad level, giving a slight outcrop of coal A, rise again for a short distance and finally disappear a mile and a half below Farmer's Station, where the bluffs are all conglomerate. Here coal A, has been worked by adit and shaft, one to two feet thick, and comparatively good. Thus, descending grade all the trip, one has geologically risen from the Keokuk through St. Louis and Chester beds to near the top of the Conglomerate, more than 300 feet.

Good quarry beds of conglomerate sandstone are found

here (Greene county), convenient to the railroad. Coal A in the vicinity of Freedom is irregular, non-persistent and deceitful. Money and time spent in its exploration will meet little or no returns.

The Chester group superimposes the St. Louis limestone in the areas which we have been just describing, and is found in regions immediately to the west of the latter. The sandstone member does not often afford stone of superior quality, but at a few locations it has been utilized for foundations, etc. The upper member of the Chester, the Kaskaskia limestone, fixes the top of the sub-carboniferous, and is easily recognized. Its outcrops have already been described, and are marked by the K'k. L. on the accompanying map.

Rattlesnake valley is a narrow cut from north to south, 100 to 250 feet deep. The bed of the valley is in the St. Louis limestone, containing but few fossils, generally argillaceous, and at the bridge leading west from Spencer, presenting some beds of clay-stone well suited for mixing with lime in the manufacture of cement. Here also some large specimens of drift quartzose fire-clay were noted, which undoubtedly had been torn from the top of Jones' hill, near Cataract and brought hither by ice. The eastern bluff of the valley is as a rule capped with Chester sandstone, the western by the conglomerate sandrock and the horizon of coal A, as at Fender's hill, Criss' hill, etc. One outlier of conglomerate and coal A occurs on Cantwell's hill, near Santa Fe. All these strata dip to the west, consequently permanent springs of great volume flow out from the eastern bluff.

The upper valley contains terraces of glacial drift, pebbles and blue clay, and just east of Spangler's hill, near Cataract, is a low gap by which the glacial current with Eel river once found doorway to Rattlesnake; a cut of 60 or 70 feet, 80 rods long, would return the former stream to its old channel.

SECTION AT SPANGLER'S HILL.

	Ft.	In.
Soil and drift	20	00
Conglomerate sandstone	25	00
Coal A, parting and iron ore	2	00
Bituminous shale	15	00
Kaskaskia limestone, with characteristic fossils	14	00
Chester sandstone, shaly	55	00
Gray shale	15	00
Argillaceous limestone of St. Louis group to top of falls	20	00
	166	00

The dip of the rocks west from this point to Jordan, is locally 120 feet to the mile, the Kaskaskia limestone being seen on Dr. Jones' land, northwest quarter section 2, township 11, range 4, in the bottom of a very deep ravine.

Cataract village takes name from the double falls of Eel, and derives support from the mills, etc., here situate. It was once the milling and mercantile center for a large area of country, before the day of railways. The river, within a distance of three-fourths of a mile, by two plunges, falls 81 feet, passing through a deep, narrow channel cut in St. Louis limestone.

The falls are owned by Burton, Shoemaker & Co., of Indianapolis, with several hundred acres of adjacent timber land. The upper falls are reinforced by a low dam. The water is carried by a box race to a wrought iron flume, 26 feet perpendicular length, and of 42 inches diameter, driving two central discharge wheels 30 inches in diameter, with force of 18-horse power. The force is sufficient to drive two buhrs and their machinery for an average of nine months. For three months the stream averages fifty times, and for five months ten times more water than is used.

At the time of my visit the river was full, and the scene one of interest and grandeur. From a floor of limestone, the river, with rapid plunges and bounds, descends 25 feet, and then at a single leap thunders in a stream of white foam and spray to the abyss; a beautiful rainbow spangles the spray which rises from the boiling cauldron. The best

view is from an unpleasant stand-point among the machinery under the mill. The descent from the top of the lower falls is 45 feet. Less than a mile below, the river, flowing with sluggish current, is suddenly seized with new life and impulses. Hurrying along a short rapid it makes clean the splendid leap of 30 feet, breaking in masses of foam and clouds of spray, and passes off in a dark stream flecked with frothy islands of floating silver. Below the second falls is a large amphitheater, with precipitous or overhanging sides of limestone, which is filled with sharp echoes and continual roar of the ever resounding cataract. Niches and recesses in the walls were festooned with drooping shrubs and plants, even behind the airy sheet of water ferns and trailing creepers are modestly nestled away, contrasting their emerald hues with the foam and spray, each frond and leaf tipped with a sparkling drop of crystal purity.

The cataracts of Eel are the grandest falls in this region of the west. They are favorably known to pic-nic parties and tourists, and in combination with the deep canyon-like valley at the narrows, the gap above the falls, the wide view from Spangler's Hill, comprise scenes of romantic beauty and wildness, full of enjoyment and interest, and worth the attention of pleasure seekers.

Sixty feet below the second fall, a strong stream of water gushes out of the northern wall of the amphitheater. It indicates the mode by which nature has cut a way through and under the beds of limestone and formed within a recent period the present channel of the river. In the course of time this underflow will undermine this fall, or remove it further back.

Just below the upper falls is an overhanging cliff 50 feet high. The crest is fringed with shrubs and flowering plants. Two children playing here, the boy of 12 years, straining to gather flowers, fell over; the little sister, seeking her lost brother, slipped and likewise made the terrible fall to the rocky floor. Insensible when found, they soon recovered, owing their lives to the bushes and shrubs which

slightly retarded their descent. This is known as the "Child's Leap." A pet deer, attempting to cross above the upper falls, was caught by the current at high-water, it made the fearful plunge, and rising from the boiling basin swam out.

In winter the cataracts put on their festal robes. The trickling springs flute and corrugate the sides of the chasm with mouldings, columns and pilasters of ice. The trailing bushes and limbs of trees are coated by the ever rising spray, and every terminal twig is gemmed with lustrous crystals, which, in the sunshine, blaze with a thousand tiny rainbows. This vicinity may be visited from Cloverdale or Gosport, on the Louisville and Chicago Railway, respectively 8 and 10 miles distant.

The sharp dip of strata south and west from Cataract, gives within a space of two miles, a very extensive geological view and of some interest, although but few fossils are found in good condition.

SECTION NEAR CATARACT.

(Connected.)

	Ft.		Ft.	In.
Conglomerate sandstone	20	to	60	00
Coal A	00		2	00
Aluminous shale	20	to	10	00
Kaskaskia limestone	10	to	20	00
Chester sandstone	60	to	90	00
St. Louis limestone			85	00
Keokuk group ?			11	00
			281	00

A very narrow ridge southwest of Fender's hill, separates Eel valley from the head of Jordan, between which and Six Mile creek by Jordan village, low gaps already mentioned present an available approach to the block coals from Indianapolis, worthy the attention of engineers.

The outlines of the conglomerate sandstone are mentioned in the description of the general section. It occupies a belt two to three miles wide, from north to south across

the county near or a little west of the meridian, between ranges three and four, but with formations boldly extended westwardly at the northwest and southwest corners. From a number of sections taken, two will be given, to show the general structure of this deposit:

SECTION AT EVANS'.

(Northeast quarter, section 28, township 11, range 4.)

	Ft.	In.
Soil and surface	16	00
Yellow sandstone	8	00
Blue shale with ironstone	10	00
Black slate. Coal B		08
Fire-clay	2	00
Coarse sandrock	28	00
Massive conglomerate, white and yellow—good grit	30	00
Soft white sandstone	3	06
Blue pyritous shale	12	00
Carbonate of iron, band and kidneys		08
Black clod	1	10
Coal A, bright	1	08
Blue shale with iron ore	12	00
Kaskaskia limestone in creek	11	00
	137	04

In this sandrock many beautiful specimens of *Lepidodrendron*, *Sigillaria*, *Stigmaria* and *Calamites*, have been found by Mr. Evans. Several small outcrops of Coal A were reported in the neighborhood, among others at William's bank, southwest quarter section 28, township 11, range 4.

At Matthew King's, southeast quarter, section 6, township 10, range 4, the top of the conglomerate is eroded. The following section is seen in a romantic amphitheater with overhanging sides:

SECTION AT "BUZZARD GULCH."

	Ft.	In.
Soil	20	00
White conglomerate gritstone	15	00
Massive white stone—grindstone grit	8	00
Heavy bedded conglomerate	12	00
Coal A	1	00
Fissile sandstone	15	00
Blue pyritous shale with excellent nodular iron ore	20	00
Kaskaskia limestone	20	00
	111	00

Some giant oaks were seen and measured on the Evans and Kings farms; the latter was carefully laid down to grass from which good returns were received.

The outcrops of coal A, near Cataract, Needmore, Jordan-village, Atkinsonville and Vandalia, are marked on the map accompanying this report. The coal is generally sulphurous and impure, and of no great value, although a few openings give a fair to good coal, a further list is not necessary. The workings only show a thickness of 12 to 18 inches. At an outcrop on the farm of John and Rolla Wright, on the west half of section 23, township 10, range 5, the Kaskaskia limestone is well developed with characteristic fossils, including *Pentremites Godoni*, plates of *Cyathocrinus*, etc., and if the limestone is persistent in level, it superimposes coal A. The connection of the strata could not well be seen.

Middletown is situated in the midst of a level or gently rolling plateau. The soil is more than ordinary and produces good crops of wheat, corn and grass. Some forests of excellent timber were noticed. A large amount of lumber, staves, headings, etc., is prepared and shipped. The warm loamy soil is well adapted for the growth of fruit. The orchards were thrifty, prolific, and rarely fail. Notwithstanding the universal failure throughout our country, of tender fruits, some peach trees were in bearing. Jacob Long has 2000 Concord vines in model order, with an orchard of fine apple and peach trees. The vines wer

hanging full of grapes, in fact an arbor was shaded as much by the rich clusters overhead, as by the leaves. The vines are only four years old, but the crop of 1874 was seven tons. Besides marketing wagon loads, he manufactured 400 gallons of wine, which was of good body and finely flavored with fruity bouquet.

The surface rock about the village is the lower member of the conglomerate sandstone, with cuts in ravines to the limestone member of the Chester group. Coal A is developed at several openings, yielding some good fat coal, and at two localities an excellent band of cannel of small thickness. A single outcrop of coal B is reported on section 14, township 9, range 5. These coals have been tested for local use, but are thin and will not pay for expensive work. Two miles northwest of town are the favorably known banks of L. C. & F. Arney and Joseph Needy, respectively, in the northwest and southwest quarter of section 9, township 9, range 5. These banks have been worked for about 25 years for local use, yielding nearly a million bushels. The following section was taken at Arney's:

SECTION AT ARNEY'S BANK.

			Ft.	In.
Slope			74	00
Gray shale and soapstone			7	00
Pyritous band			2	00
Coal I, block			3	00
Indurated clay			1	00
Gray shale, with Kidney ore			11	00
Coal B:				
Laminated rough		06		
Laminated good		06		
Splinty cannel		04		
Choice caking	1	06		
Rough coal		02	3	02
			101	02

Arney and Needy's coal is of excellent quality, compares favorably with the best coking coal in the country and burns with a brilliant sheet of white flame to a white ash without clinker. Coke from this bank was formerly used at Seward's

foundry at Bloomington, and was found equal, if not superior to that of Pittsburg; softening instead of hardening the metal. It is superior for blacksmith's use, and sought for burning in grates on account of the brilliant illumination of the flame. Where known it is reported as selling for four cents a bushel more than block or other western coal for household purposes.

The area of coal B at this locality is limited, and generally found on elevated knolls and ridges, the base of which is of conglomerate. Openings have been made in sections 21, 17 and 8, but were not in work.

On the well-improved grazing farm of John Haxton, southeast quarter section 29, township 9, range 5, an assortment of the best blooded cattle and hogs was seen. He reports the following bore:

SECTION IN HAXTON'S BORE.

	Ft.	In.
Clay soil	9	00
Coal		04
Conglomerate sandstone, with glacial striæ	32	00
Chester limestone	18	00
Sandstone	3	00
	64	00

On Hubbell's and Dillon's farm at Mt. Good, chalybeate springs were noted, charged with iron from the pyritous shales at the base of the coal measures. Near the latter, on land of J. K. Wells', southwest quarter, section 16, township 9, range 5, occurs an outcrop of typical pebbly conglomerate, which has been locally used for "millstone grit."

Red and yellow ochre is found in a bed said to be six feet thick on the Sloo land, northwest quarter of southeast quarter of section 20, township 9, range 5. Three openings have been made. Its origin is probably due to the decomposition of ferruginous shales, and the deposit of iron and clay therefrom. The paint is of good quality, but on full experiment a demand for the article could not be found.

At Isaac Needy's, southeast quarter of section 17, township 9, range 5, the following section is reported:

SECTION AT NEEDY'S WELL.

	Ft.	In.
Clay and soil	12	00
Coal I	2	00
Stony clay	3	00
Siliceous shale	14	00
Coal B, choice	4	09
Plastic fire-clay	4	00
	39	09

Many other outcrops of coal I and B were reported in this vicinity and the localities visited. Generally they were not in work, and the thickness of the seams could not be measured. The following connected section, taken on sections 17 and 20, township 9, range 5, gives a general view of the stratification:

NEEDY—HUBBELL SECTION.

	Ft.	In.
Soil	20	00
Coal I	2	06
Shaly sandstone	17	00
Coal B	3 to 4	09
Conglomerate	75	00
Coal A	1	08
Sandstone	43	00
Chester beds, Kaskaskia limestone	17	00
	180	11

I am indebted to the kindness of Niblock, Zimmerman & Co. for a record of the following bores, viz:

BORES ON WARNER FARM.

(Southeast quarter, section 24, township 9, range 6.)

FIRST HOLE.

	F.	In.
Surface clay	7	00
Gray sandstone	2	06
Blue sandy shale	3	08
Black shale	1	04
Blue sandstone	4	06
Siliceous shale	3	00
Coal	1	00

	Ft.	In.
Clay	5	04
Blue shale	6	00
Iron ore		06
Sandy shale	13	11
Blue shale	4	03
Coal and shale	3	00
Fire clay	1	06
	57	06

SECOND HOLE.

	Ft.	In.
Surface clay	4	00
Slaty fire clay	4	08
Gray siliceous shale	26	04
White sandstone	4	06
Gray siliceous shale	21	02
	60	08

THIRD HOLE.

	Ft.	In.
Surface clay	5	06
Yellow sandstone	14	00
Blue sandstone	1	00
Gray shale	2	04
Gray sandstone	40	02
White sandstone	1	00
	65	00

FOURTH HOLE.

	Ft.	In.
Surface clay	4	00
Gray siliceous shale	23	06
Blue shale	3	00
Coal (B ?)	3	04
Fire clay	3	02
Iron ore		07
White shale—Iron stone	1	00
White sandstone, with iron balls	8	11
Gray sandstone	14	06
Blue siliceous shale	20	03
Conglomerate sandstone	23	09
	104	00

Also, by the same parties, the following bores:

SECTION IN BORES ON WINTER'S FARM.

(Northeast quarter, section 23, township 9, range 6.)

FIRST HOLE.

	Ft.	In.
Surface clay	4	06
Sandstone	5	02
Coal		04
Fire clay	5	00
Blue siliceous shale	19	05
Coal	2	10
Fire clay	4	03
Siliceous shale	45	04
	86	10

SECOND HOLE.

Surface clay	17	06
Hardpan	10	06
Sandstone	1	00
Rotten coal		08
Fire clay	7	06
Blue siliceous shale	8	08
Blue shale	3	00
Fire clay	2	00
	50	10

THIRD HOLE.

	Ft.	In.
Surface clay	3	06
Blue shale	21	01
Coal	3	06
Fire clay		06
	28	07

LOVE'S FARM.

Southeast quarter, section 23, township 9, range 6.

Surface clay	30	06
Hard pan	12	00
White sandstone	4	08
Fire clay	2	00
	49	02

Thanks are due to A. Grim and R. E. Winnett, for the record of the following tabulated bores in south half of

section 11, and the north half of section 14, township 9, range 6. Each locality is brought to the datum line of the railroad grade by addition to or subtraction from the first space; that is, the amount that the surface at any bore is below grade is added to the first column of spaces, or, if above grade, is taken from the same. The bores are located on plat of said land attached to the map of Owen county.

The bores given above and heretofore vary greatly, and show that important irregularities exist, which forbid the sinking of shafts without first proving the territory. The tabulated bores terminated as a rule in or at the limestone member of the Chester group, and show that the ground was fully proven.

West of Lick creek the land becomes nearly level, sloping gradually to the "bottoms" of Eel river. The soil is alluvial, and produces good crops of cereals and grasses. The forests were once unequaled, and the surviving timber is of extra size and value.

Stockton is in the midst of this productive land, and is a thrifty village. Coal is mined only for local use, and none of the banks were in work. Several openings and outcrops of coals I and B are carefully noted on the map, all ranging from two to three and a half feet, and averaging about three feet.

Jesse Reagan works a strip bank with three openings on northeast section 13, township 9, range 6. This coal has a good reputation for steam and grate use, but is rather splinty for blacksmith use.

SECTION AT REAGAN'S BANK.

			Ft.	In.
Clay and gray shale			5	00
Soft, black shale				04
Coal B:				
Semi block coal		09		
Lustrous cubic coal		03		
Block coal	1	06	3	06
Semi block coal			1	00
Stony clay			2	00
			10	00

SUMMARY

Of Bores on south half section 11 and north half section 14, township 9, range 6. (Owen county.)

No. of Bore.	Space from datum.	1st Coal.	Space.	2d Coal.	Space.	3d Coal.	Space.	4th Coal.	Space to bottom of Bore.	Total below datum of R.R. grade.
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	In. Ft.	Ft. In.	Ft. In.
1	69 06	2 06	16 00	3 03	9 06	2 08	62 C9	......	......	164 02
2	74 00	2 03	11 00	2 03	21 03	3 11	1 00	......	......	115 06
3	100 00	Eroded	....	2 06	23 00	......	....	......	......	125 05
4	59 06	2 01	2 00	1 02	29 06	3 09	2 00	......	......	100 00
5	30 00	1 00	59 07	3 07	1 00	......	....	......	......	95 02
6	51 06	1 06	17 00	2 04	16 00	2 04	18 06	2 09	9 10	121 09
7	39 00	1 00	22 00	2 00	14 06	2 10	19 00	2 02	3 00	105 00
8	35 06	0 08	31 00	1 06	20 00	2 09	11 08	1 08	7 05	112 02
9	60 00	3 00	18 06	2 08	18 03	1 09	1 00	......	......	106 02
10	42 06	1 00	27 00	2 00	8 00	1 06	18 00	3 03	1 00	104 03
11	68 00	2 06	16 06	3 01	16 06	3 09	1 06	......	......	113 10
12	60 00	1 08	10 00	1 06	21 02	2 00	0 06	1 00	1 00	98 10
13	63 00	1 08	31 00	3 00	11 00	2 00	3 00	.....	......	114 08
14	44 06	1 08	14 00	1 08	27 06	1 03	22 01	......	......	112 06
15	69 00	2 00	10 00	2 00	23 00	3 06	1 00	......	.....	110 06
16	99 02	Eroded	....	3 02	1 00	......	....	......	......	103 04
17	56 04	1 08	33 00	3 04	1 00	......	....	......	......	95 06
18	77 00	2 00	26 06	......	....	......	....	......	......	105 06
19	96 06	Eroded	....	3 06	1 00	......	....	......	......	101 00
20	61 06	1 00	34 08	3 04	1 00	......	....	......	......	101 06
21	66 00	2 00	36 03	3 06	1 00	......	....	......	......	108 09
22	36 00	1 00	29 00	1 06	30 06	3 06	1 00	......	......	102 06
23	29 00	1 00	28 00	1 08	33 00	3 06	1 00	......	......	97 02
24	47 00	2 00	33 00	3 05	1 00	......	....	......	......	86 05
25	68 00	2 00	27 06	2 06	1 06	......	....	......	......	101 06
26	66 00	2 02	34 06	3 03	1 00	......	....	......	......	106 11

TABLE No. 2.

Location, etc., of Bores on south half section 11, and north half section 14, township 9, range 6. (Owen county.)

Bore No.	Course from Shaft.	Distance from Shaft	Above datum. Subtracted in No. 1.	Below datum. Added in No. 1.	Actual depth from Surface.
		Feet.			Ft. In.
1	S., 11° E.	321	Grade.	....	164 02
2	S., 5½° E.	1531	....	12.00	103 11
3	N., 87½° E.	2020	....	65.00	60 06
4	S., 45° E.	2400	....	15.00	85 00
5	N., 2° E.	1996	3.00	....	98 02
6	S., 65° W.	152	Grade.	....	121 09
7	N., 20° W.	153	Grade.	....	105 00
8	N., 59° E.	164	Grade.	....	112 02
9	N., 59° E.	314	Grade.	....	105 02
10	S., 59° E.	310	....	3.00	101 03
11	S., 15° E.	618	....	2.00	111 10
12	N., 80° E.	930	....	30.00	68 10
13	North.	387	3.00	....	117 08
14	N., 53° W.	432	....	4.00	108 08
15	S., 10° E.	1000	....	2.00	108 06
16	S., 79° E.	1607	....	55.00	48 04
17	North.	1250	4.00	....	99 06
18	West.	1650	....	20.00	85 06
19	S., 62° E.	1676	....	45.00	56 00
20	S., 54° E.	1200	....	8.00	93 06
21	S., 35° E.	1650	....	4.00	104 09
22	N., 35° W.	1150	....	5.00	97 06
23	N., 35° W.	1150	....	5.00	92 02
24	N., 25° W.	2400	2.00	....	88 05
25	N., 80° W.	1250	....	8.00	93 06
26	S., 60° E.	650	Grade.	....	106 11

Denmark is on a valley plain, surrounded by magnificent forests. The vicinity is settled by Dutchmen and Dunkards, whose industry and thrift are well known. The alluvial soil deeply covers the rocks, allowing but few exposures of coals I and J, which are located on the map. The seams are from three to three and a half feet thick; composed of block coal, with layers of splinty cannel of great purity and value. The last melts to a pasty mass in combustion, leaves but little ash, and is nearly as pure as Albertite. The Burger, Croft, Goshorn and Rowe banks, have long been worked, and deservedly bear a good reputation. J. R. Merrell, an experienced blacksmith, says the Croft coal is far preferable to that from Pittsburg for smiths use.

George Croft works his strip bank on northwest quarter section 23, township 10, range 6. It is an excellent coal. The following section occurs:

SECTION AT CROFT'S MINE.

			Ft.	In.
Clay and drift			5	00
Gray shale soapstone			3	00
COAL I ?.				
Semi-caking coal	0	06		
Choice block	2	00		
Pasty cannel, "Albertite"	0	08	3	02
Clay			2	00
			12	02

It may be seen that going west from Patricksburg the coals become less dry, contain more volatile matter, and although superior as fuel, are less suited, without coking, to bear the burden of a blast furnace. In quality they are very similar to coal B.

Patricksburg is an unique village. The inhabitants are generally skilled mechanics, industrious, progressive, able and willing to supply local demands, and compete in outside markets. It is on the axis of the great eastern protrusion of the coal measures. The conglomerate is depressed below the surface sufficiently to allow coal B to under-run the vicinage and coal I to be found in all the hills and ridges.

The latter is grandly developed, showing a thickness of from three and a half to over six feet of pure choice block coal, equal to the best in this or any State. No district can boast such a combination of thick seams, and at the same time so many varieties, comprising choice block, choice caking and extra cannel coal. A mere list of the mines, outcrops and openings marked upon the map would occupy too much space, consequently we must refer to it and merely mention a few representative banks which happened to be in work:

SECTION AT PATRICKSBURG.

(Connected.)	Ft.		Ft.	In.
Soil, clay	50	to	10	00
Gray shale	10	to	1	00
Coal I, block	4	to	7	00
Gray shale, iron balls			10	00
Indurated clay	20	to	4	00
Coal B, caking	1	to	2	00
Fire clay			2	00
Gray siliceous shale and sandstone			20	00
Massive conglomerate	20	to	40	00
Coal A, caking or cannel	0	to	1	06
Shale or sandrock	5	to	15	00
Kaskaskia limestone, Chester			12	00
			124	06

On Wm. S. Norris' land, southeast quarter, section 21 township 10, range 5, coal I is found five feet thick in well. Coal B is worked in the brook. A considerable amount of good iron ore, pure and in large concretions, is found in the shale over B, in quantity to justify mining:

SECTION AT NORRIS'.

	Ft.		Ft.	In.
Soil	4	to	10	00
Gray shale			4	00
Coal I, block	3	to	5	00
Shale and iron ore			30	00
Coal B			2	02
			51	02

SECTION AT FLETCHER'S BANK.

(Northeast quarter section 10, township 10, range 5.)

	Ft.		Ft.	In.
Soil, clay	30	to	5	00
Gray shale	5	to	8	00
COAL I, block.				
Semi-block coal	1	08		
Choice block coal	3	04		
Splinty cannel		07	5	07
Shaly Clay			5	00
			23	07

SECTION AT ROYER'S MINE.

(Northwest quarter, section 11, township 10, range 5.)

	Ft.		Ft.	In.
Soil, clay	30	to	5	00
Gray shale	4	to	10	00
COAL I, block.				
Semi-block coal	1	08		
Choice block	3	06		
Splinty cannel		10	6	00
Shaly clay			4	00
			25	00

These banks are adjoining the village on the northeast. Some good caking coal was seen on the Chambers farm, southwest quarter of section 3, township 10, range 5, which is excellent for smiths use, and is so free from sulphur that it bears stocking well. It is thin and worked by stripping. A singular horseback, which divides the coal into two seams, was noticed at southeast corner of the southwest quarter, section 3, township 10, range 5. It was composed of gray fire clay, and contained worn *Stigmaria* and rootlets of coal plants.

Near the residence of J. Frantz, southwest corner of section 1, township 10, range 6, from a well 4 feet square, a ton of superior iron ore was obtained in passing the shale bed, five feet thick, which overlies coal B. Many wells have met the same bed of ore, and it is believed the

quantity and quality would justify examination and probably mining.

The Overholzer bank is worked by stripping, the coal is irregular in thickness, but at the mine presented a face of six feet one inch. It is good block, with partings of fat caking coal. In the vicinity of Overholzer's and thence north coal I is generally eroded, but coal B may be found just below the ore bed.

SECTION AT BRAMMER'S.

(Southeast quarter, northwest quarter, section 1, township 10, range 5).

	Ft.	In.
Slope	30	00
Coal I, impure	1	08
Gray shale—covered	27	00
Coal B, caking	1	06
Shale and conglomerate	58	00
Coal A	1	00
	118	08

Another outcrop on the northwest quarter, northwest quarter of same section gives the following:

SECTION AT BRAMMER'S CANNEL COAL BANK.

	Ft.	In.
Slope	40	00
Blue and gray shale	4	00
Quartzose sandstone	1	02
Choice cannel coal		08
Resinous coal	1 to 2	00
Blue and gray bituminous shale	8	00
Massive sandrock—conglomerate	12	00
	67	10

Brammer's cannel coal, although thin, is the best I have ever seen. See analysis. Similar coal is found at other outcrops in the neighborhood.

Special thanks must be returned to sheriff Ham. Moffett, for the numbers of the lands throughout the coal regions, by which outcrops, etc., are located on the map, and for guidance to points which otherwise could not have been

visited. It is believed that every opening and outcrop in the county was visited, and as many are marked on the map as was possible upon so limited a scale.

ARCHÆOLOGY.

Religious mounds and mounds of habitation, structures peculiar to our most ancient predecessors, were not found in the county, yet trophies in stone similar to those known to be of that age are not uncommon, viz: a copper needle, an iron ore plumb bob, stone axes, chisels, spear and arrow points, striped slate ornaments, tubes and gorgets. Still there are many mounds which, from their structure and contents, are referred to the intermediate riparian race, who succeeded the Mound Builders, and who yielded in turn to the savages. They were probably closely allied to the Southern Indians, visited by De Soto, and of whom the "Natches" were representatives.

The residence of J. A. Coffey is on a bluff west of and 40 feet above Spencer. A hillock obstructed the view, and in leveling which, it was found to be a sepulchural mound, 60 feet in diameter and 19 feet high. In the center was collected a promiscuous mass of human bones, soft from the decay of ages, amounting to 150 bushels, or three cords, and estimated to represent 150 persons—a mass 6 feet high and 15 in diameter, in a sharp, conical heap. This was covered, 1st, with a two-feet layer of white sand, carried nearly a mile from the nearest bar in the river, a part of which had sifted down among the bones put away dry and clean at some stated occasion; 2d, the soft shroud of sand was enclosed in a sheet of clay 18 inches thick, red as if burned, and still above, the mound was built up with common loam. In this upper deposit was found two intrusive graves of the late savages, in which the bones were but little decayed. With the latter were flint arrow points and coarsely polished stones.

A quarter of a mile south of Freedom, Dr. A. J. Minnich opened a mound four feet high and thirty feet in diameter. Within was a vault which required at least two or

three wagon loads of stone for its construction. Some of this material was in slabs 4 feet square, and had been carried from the bluff 300 yards distant. The vault contained about thirty skeletons, the bones promiscuously mixed and evidently disjointed before their deposit. The bones were soft and porous, and crumbled to dust on exposure. They were shrouded in soft river sand, and plastered over with red (burned) clay.

Less than a mile north of Freedom a mound was partly removed to grade the railway. It contained more than 100 skeletons. The vault was made by placing flat stones over the head, lapping toward the center, to prevent removal by animals, and then covering with loam.

On the McBride farm, adjoining the last, is a mound 12 feet high and 150 feet in diameter, with two smaller ones attached at the southwest. On top of the large mound was a circle of stone vaults 6 feet long, 2 wide and deep, covering the whole top, each grave containing two or more skeletons, with heads toward the center and bodies radiating out like the spokes of a wheel. The bones indicated persons from four feet ten inches to five feet and a half high. No ornaments or utensils were found in the vaults. Another charnel vault had contained a low heap of bones, and the flat stones which covered it were placed the inverse of shingle work, commencing at the top and finishing at the bottom, consequently it was with difficulty opened.

Mr. J. W. Archer saw an interesting funeral in California, at which the bodies were first consumed by fire, and over the ashes a very respectable mound was built in commemoration. Did space allow, a description would give a clue to the origin of some of our more common mounds.

ECONOMIC GEOLOGY.

The characteristic soil in different parts of the county has been already noted. It is known that any soil will deteriorate unless managed with care, and supported by rest and fertilization. Continued cropping is exhaustive to the best,

but on thin soils, is death. We can not too earnestly suggest that in the hilly regions the grounds could be profitably seeded to orchard and similar grasses, and that such a course would restore and maintain the soil. Cool springs in great volume invite attention to cheese and butter making.

TIMBER.

Mention has been made of choice forests in different parts. These comprise all the best varieties found in the State. The growth is exceptional. Specimens of oak were measured, at several stations, 4, 5 and 6 feet in diameter, with trunks straight as an arrow, without limbs or fault, 50 to 80 feet long. Some poplar trees were still larger, all of perfect growth, without shake or knot. Such timber is valuable and should be used only by skilful workmen for mechanical objects.

CLAY.

Bricks are made throughout the county. Clay for this purpose is common and abundant. The under-clays of the coals furnishes good material for fire brick, pottery and terra-cotta ware. Some modified clays were seen on Six Mile, etc., which were superior for potters use.

"KAOLIN."

Specimens of porcelain clay (*Silicate of Alumina*), were found on Jordan, Rattlesnake and the head waters of Raccoon creeks. Explorations have been made by Messrs. Allison who report the discovery of a bed several feet thick.

At a subsequent visit, a shaft had been put down twelve feet, ten of which contained nuggets, pockets and masses of Kaolin in a matrix of fine, pure plastic yellow clay, and a bore found that the bed was equally developed fifteen feet below, making a total depth of twenty-five feet, of which about 20 per cent. was Kaolin. From the irregular and diagonal bedding it owes its origin to fluviatile action, and indicates a large and pure deposit in the vicinity; it is at the horizon below the base of the Conglomerate at which

such clays are found in Parke and Lawrence and may be expected in Greene, Monroe, Martin, Pike and Dubois counties. The opening was made on the land of Henry Ritter, northwest quarter, section 7, township 9, range 3. Another promising outcrop, as yet undeveloped, occurs seven miles west of Spencer, on the land of Richard Keene, northeast and southeast quarter, section 27, township 11, range 4. The specimens selected are of excellent quality, as pure as the best, and promise a grand enlargement of our home industries. Prof. Cox has suggested the name *Indianaite* for this valuable mineral.

STONE.

From the preceding report it will be readily seen that stone is abundant, of good quality, and in great variety, comprising sawing limestone, compact limestone, stone for burning, lithographic and rubble stone, grit, glass and polishing stone, with clays suitable for the manufacture of hydraulic cement. The rocky strata are a vast treasure with *"millions in it."* Enterprise and labor will transmute the very hills into current gold.

COAL.

The coals of this county are fully equal to the best, and are in great variety. The block coals are suited to the use of the blast furnace. Coal B is, at certain stations, almost pure, burning with great flame and but little ash. If found free from disseminated sulphur, etc., it would seem that the splinty cannel, B, is worthy the attention of gas makers.

MEDICINAL SPRINGS.

Chalybeate water has well attested curative properties. The springs mentioned in local details merit and will command the attention of invalids.

PAINT.

The paint beds near Middletown, on section 20, township 9, range 5, and near Commissioner Stutz's farm, are extensive and of good quality. The ochre needs washing, when it will compete in the markets. A sufficient demand can hardly be found for car loads of paint.

FRUIT.

The high hills and divides are admirably suited for fruit growing. Immunity is thus secured against the effects of sudden changes in temperature*. No more inviting field can be found, nor is it a matter of hazard. The missionary experiments of Long, at Arney, and Criss, near Vandalia, are demonstrative, proving that the calling is sure, profitable and pleasant.

In conclusion, thanks are returned to the citizens of Owen county for kind co-operation and assistance. Every aid was tendered and freely given. Special acknowledgements are due to Ham. Moffet, J. W. Archer, J. C. Simpson, Hon. W. M. Franklin, J. N. Allison, J. N. Merrill, Samuel Ray, J. A. Coffey, A. J. Tipton, Jacob Long, Jno. Haxton, J. L. Stoots, Wm. Winters, C. Acuff, Hon. J. C. Robinson, Hon. W. E. Dittemore, R. H. Gentry, J. S. Meek, H. Richards, O. E. Foster, W. Coffey, Calvin Fletcher, R. H. Gouty, Henry Dyer, Dr. Minnich, S. F. Evans, Dr. J. M. Jones, T. D. Stillwell, James Beaman, Hon. W. A. Montgomery, T. C. Bailey, L. M. Hays, Fred. Goss, D. B. Buskirk, Jesse Rogers and Dr. McDonald.

*For additional facts on this point, see reports of Knox, Gibson and Lawrence counties, 1874.

MONTGOMERY COUNTY.

BY JOHN COLLETT.

Montgomery county is bounded north by Tippecanoe, east by Clinton, Boone and Hendricks, south by Putnam and Parke, and west by Parke and Fountain, and contains 504 square miles or 322,560 acres. Crawfordsville, the seat of Justice, is situate near the geographic center and is 48 miles northwest from Indianapolis. The principal villages are Pleasant Hill, Linden, Darlington, Shannondale, Valley City, Lynnsburg, Whitesville, Ladoga, Ashby, Parkersburg, Waveland, Alamo, Yountsville and Waynetown.

The drainage takes direction from the dip of the underlying rocks, generally a little west of southwest. The main stream is Rock river or Sugar creek, which enters south of the northeast corner and traversing the central areas, passes out six miles north of the southwest corner of the county. Its affluents from the north are Lye and Black creeks; from the south, Walnut, Offield and Indian creeks. The southern and southeastern parts are drained by Big and Little Raccoon creeks, and at the northwest by Coal creek, which flows directly into the Wabash. These streams, with their numerous tributaries, are fed by springs that flow out of the the great sponge-like mass of clay and gravel at its junction with the rocky frame work of the earth. They are, therefore, reliable streams, and furnish an abundance of water for agricultural and mechanical needs.

The surface of the country is pleasantly diversified, combining in the highest degree the useful with the agreeable. The western part, near the principal streams, is hilly and broken; in the north and center it is gently undulating, and at the east and southeast flat and level. The latter regions were originally clothed with a heavy growth of fine forest trees. In the north, extensive prairies prevailed, surrounded by glades, "openings" and groves of timber. The soil is everywhere fertile, and produces remunerative crops of corn, wheat, oats, grass, fruit, etc. It is especially adapted to the growth of blue grass the "gold finder" of Indiana. The health of the region is proverbial.

The following table of altitudes, deduced from uncompensated barometric observations with Stansberry and Williams' tables for a basis, are only approximate, but indicate such an elevation as insures exemption from some of the worst forms of malaria.

TABLE OF ALTITUDES.

(Above the Ocean).

	Feet.
Crawfordsville	749
Linden	763
Divide, seven miles north of Crawfordsville	799
Darlington	752
Mace—Frederick	788
Valley City—New Ross	838
Ladoga	820
Ashby	837
Waveland	694
Bodine's Mill—Sugar Creek	598
Alamo	839
Glacial moraines—near Alamo	870
Waynetown	735
Indianapolis	698
Terre Haute	494
Lafayette	538

GEOLOGY.

(Recent Geology.)

The surface deposits are due to three separate epochs of the Quaternary period, and are classified as follows:

QUATERNARY PERIOD.

	Ft.		Ft.
Alluvium	0	to	20
Fluviatile drift and terraces	0	to	80
Lacustral beds	0	to	50
Glacial drift	10	to	120

During the long period in which the Triassic, Jurassic, Cretaceous and Tertiary seas successively came into existence, lived their age, and prepared the way for the life and time to follow in regions to the south and west of the Mississippi, it is probable that this part of central Indiana was elevated and continually rising above the level of the ocean, presenting the bare, rocky structure of the earth to the elements, for we find no evidence of these ages *in place*, except the erosive phenomena, and the deep cut river channels, now filled with the debris of later times.

THE GLACIAL EPOCH.

The Glacial epoch succeeds this hiatus, leveling down former inequalities, filling up old valleys, and covering the hitherto bare surface with deep beds of clay, gravel, sand and boulders. In a practical view, this is one of the most interesting studies of the geologist. The surface deposits and resulting soil determine the value and kind of productions of a country, and give life and mental character to its inhabitants. A clay must be devoted to the grasses and grazing, the addition of siliceous material makes a loam capable of a wider productive range, but combining and properly mingling with these the alkalies and usual minerals, gives a still greater breadth of production, and that competency which insures comfort and leisure for mutual improvement.

To the phenomena of the glacial epoch we are indebted

to a great degree for results that make this region desirable for man. A period of intense cold prevailed. A mighty river of solid ice, with its sources away off toward the pole, its southern foot terminating at about 39° 10′ north latitude, many hundred miles in width, slowly crept to the south. Its surface was covered with a large amount of angular fragments of rocks from overhanging cliffs at the north, and with gravel, sand, etc. Such material absorbing warmth from the short Arctic summer, would gradually sink in their matrix, or falling through numerous crevasses and water-ways, would reach the bed rock over which the glacier was advancing, the softer material would be ground in this giant mill to powdered clay and sand, while the more obdurate rocks would be rounded, polished and striated and survive as gravel and boulders which we find so plentiful in this region. The imported rocks are generally crystalline, with a reasonable percentage from the Silurian and Devonian beds, which, in combination with the native shales, lime and sandstone, thoroughly comminuted and mingled, constituted a perfect soil, because it comprises in available form the constituent materials of all the paleozoic strata.

The boulder drift may be described as a vast bed of gray clay or hard-pan, sand, gravel and boulders mixed "pell mell" or obscurely and irregularly stratified with slight partings of sand and gravel, at wide intervals, impervious to air and holding water with tenacity, it acts as a great sponge, grasping the rain-falls to feed the numerous springs which flow from its base, and maintains such an equilibrium of moisture as averts drought, and insures the perfect growth of blue grass and other plants that do not penetrate the ground to a great depth.

The earliest glacial flow in America was from the northeast (N. 80° E.), which passed up the St. Lawrence valley, hewing out the basins of lakes Ontario and Erie, and finding discharge by sluice-ways into the Ohio, Wabash and Mississippi. In the region of the lakes named, the records of this period are well preserved and easily interpreted.

Judged by the results, the work was long continued, and of great energy. Hitherto any facts indicating the extension of this flow to Indiana, have escaped attention. But a flow of such magnitude can not be supposed to have spent its force and material at the western end of lake Erie and suddenly ceased. Even then it was exhibited in great force. The natural conclusion would be that the evidence of its existence would be partially or wholly obliterated by the later flow from the north, passing directly across the vacated track of the former. Some facts have come under observation in the last year, which, although obscure, seem to throw light on a subject hitherto unsolved.

A system of canyon-like valleys were discovered in Owen and Clay counties, having the direction of the first flow, which can not be explained by any circumstances connected with the second cross-flow, and which, from the great depth of the erosion and subsequent building up with silt, dates its origin to an earlier period in the Glacial epoch. In Putnam county, and other parts of the State, are many valleys, once of great depth, although now profoundly built up, or entirely obstructed, have the direction of the axial line of the eastern lakes S. 80° W. In this county it will be observed that the trend of the ancient valleys, now occupied by the present streams, but generally more or less obliterated or obstructed, also have an east-west course varying slightly to the south. Thus the prairie depression near Linden connects directly in the northwest corner of the county with Coal creek, which is continued for some distance in this primal course. Lye creek enters near the extreme northeastern corner of the county, and after flowing in a westerly direction for six miles, suddenly turns to south, the ancient valley is plainly continued through Lye creek and Black creek swamps and Black creek valley. The obstructing agent, a vast bed of modified clay and water-washed sands are at once detected at the head of Black creek, between Linden and Crawfordsville. The discharge of water thus denied, the flow from the east would first be confined, and after reaching the maximum

capacity of the basin, be compelled to find a new line of exit to the south by Sugar creek. The obstructing dam of modified materials is the termination of a north-south ridge, and its modified nature demands the sifting and sorting process of flowing water. A lake, now known as Lye, and Black-creek swamps succeeded, originally six miles long and from one to three miles wide. The deepest wells in the basin do not find the bottom of the Lacustral silt, quick-sand and muck; and, although now drained and brought under cultivation, within the past fifty years it was covered with water. In opening ditches, drains, etc., many canoe paddles, spears and fishing implements have been found, proving that in modern times it was a constant body of water and a favorite resort for the Indian fisherman. The present channel of Lye creek, from the point where the southern bend commences, to its mouth, is by a deep, narrow valley, with steep, precipitous bluffs, which facts indicate the recent origin of this out-let.

The facts observed in relation to Sugar creek are of interest, and point more definitely to the early Glacial epoch for a solution of the phenomena observed. This stream east of Crawfordsville has a general trend of south 70° to 80° west. A few miles west of the city, and a short distance north of Yountsville, it is suddenly deflected directly to the south and southwest. Above this point, the valley bottoms are from one to two miles wide with well rounded bluffs supported by great beds of gravel and modified drift, which have been subjected to the sorting action of swift currents of water. Below Yountsville the valley is compressed, rarely exceeding a few hundred yards in width. Its precipitous or overhanging bluffs are often bare and naked cliffs of stone, indicating conclusively the recent origin of the chasm through which the stream flows, and the short period during which the bluffs have been exposed to the modifying influences of the elements, for a long exposure is nature's cure for wounds, by disintergration, wearing away exposed surfaces, removing asperities,

reducing precipices to gentle slopes, and covering their sides with fine sand and clays wrested from superior strata.

These facts, without doubt, demanded another and older outlet for Sugar creek, and if the primal direction of the stream was due to the action or results of the first ice flow, it ought to be found continuing in the original course west from Crawfordsville. Beneath that city, and in an area of several hundred acres west and southwest of it, are beds of coarse gravel and sand, having a thickness of 40 to 90 feet, of drift origin, but sorted and re-deposited by fluviatile action. The stream to whose currents its origin was due, at one time must have had its low water level as high as a terrace on which Crawfordsville is situated. This was accepted as a hint toward a solution. Starting with this level registered as a datum line on the barometer, it was found that allowing a range of less than 40 feet, between high and low water in the ancient river, at least two outlets existed, one leading more directly to Coal creek, the other trending gently southwest to Sugar Mill creek. The latter is a broad well defined valley, now somewhat of a swampy nature, and, as far as pierced by wells, say 30 to 40 feet, built up with mucky silt and quick-sand, with beds of fine gravel. It seemed evident that the ancient river not only could but actually did find egress by this way. This presumption is further sustained by the fact that deep wells and bores in search of coal have discovered a great system of deeply eroded river channels in the great level plateau in the south part of Fountain county, now entirely filled up with silt and glacial drift, and which are on the produced line in which a river of the early glacial period, would be compelled to seek the Wabash and western drainage. To these deductions we may add that a few fragmentary rocks which seem to be like the Medina sandstone of Ontario, and two nuggets of nearly a pound each, of course octahedral Champlain iron ore, were found near the present mouth of Coal creek, in the bed of "Old" Sugar creek, if our theory is correct. These facts, separately, are of little value. Combined, they hint at the solution of an obscure

chapter of nature's history, and are briefly thrown together to invite full investigation, rather than a complete solution of the enigma.

From the nature of the case, as well as from the foregoing facts, the early glacial epoch was a system complete in itself, with a cold Arctic source, a regular and exact course of flow, and with sufficient channels for the discharge of ice water at its southern and western foot, continuing through ages, in the latter period of its existence, until climatic or atmospheric reasons, its propelling force had declined, it was met at the western end of lake Erie by the northern flow, full of energy and power, and which, sweeping down along the axial lines of lakes Huron, Michigan, and the Mississippi river, overpowered the former.

To the second ice-flow we are indebted for nearly all the rocks, sands, gravel, clays, etc., of the boulder drift. As it gradually approached, crossing the track of the first, the advance water discharge would probably tear up and remove, in a greater or less degree, the surface deposits, using the valley channels already prepared; but at length, when the glacier itself, in solid mass, supported by a great cushion of plastic material crossed this region, advancing with an alternating motion, proportioned as the long arctic winters exceeded its short summers. Under such circumstances the first result would be to fill up and bridge over all former chasms and valleys, and interesting exhibits of this process were discovered in excavating the roadbed of the Louisville and Chicago railway in Putnam county. The surface rocks on the northern side were found planed off and striated, but preserving a square edge with no scars or marks on that side of the chasm; the southern side always scarred with a worn and rounded cap, as if for a time the ice had grounded against the latter and then rose over it. The case just mentioned pretty fully explains the phenomena presented here. The ice sheet, with clay, gravel and boulders in great volume, invading the ancient valley, for a time exhausted its energy in filling up and bridging the

depressions until by an inclined plane it could ascend the high lands to the south. A dyke of such material with continued accretions of ice was built up until the water-way was entirely obliterated, and a vast lake covered all the central parts of the county. A new outlet was sought and found when the water reached the maximum capacity of the basin, across the easily eroded conglomerate sandstone at the southeastern corner of the county. On the extreme highlands just south of Alamo the surface is marked by a succession of small knolls and basins disconnected, yet indicating obscurely parallel ridges, which are believed to be terminal mud moraines; the spaces between, of 80 to 190 yards, recording the annual advance and recession of the ice foot.

During some part of this period it seems that a branch glacier was deflected to the east by the highlands seven or eight miles north of Crawfordsville, near Mt. Pleasant Chapel, passing between this point and Romney, thence southeast by Darlington towards Fredericksburg, leaving a trail or dyke of immense boulders along its track, filling up some of the depressions and floating over others, by this time partly filled with water.

The resulting Lake existed a very considerable period—long enough to hew out by its waste water the present rock-walled chasm, through which Sugar creek now flows, in the southwestern part of the county. During this time all the old river beds were more or less filled up with glacial clay or gravel and lacustral muck and silt, through which the stream had afterwards to renew its valley, removeing the finer material and depositing gravel and boulders in vast beds as terraces. Beds of the latter are common about Crawfordsville but rare below Yountsville. The lacustral silt, a black, mucky mass, containing trunks and branches of trees, is seen below the terrace gravels, or is pierced in deep wells at and near the city. As the main lake was reduced by drainage, smaller isolated lakelets survived, as Black and Lye creek swamps. East of Sugar creek and south of Crawfordsville was an extensive body of

water, covering nearly 100 square miles, the silt and shore-line which is so plainly lacustral and marked that its existence could not have terminated more than a few thousand years ago. The phenomena of this basin has long been noticed and studied by Col. James H. Harney, to whom I am indebted for much information, etc., and in whose honor as the discoverer I have given it the name of *Ancient Lake Harney.*

The boulder drift deeply covers the eastern, northern and northwestern parts of the county, bearing internal evidence of its origin, as polished, striated and rounded pebbles and rocks imported from the Laurentian beds north of lake Superior. When long concentrated by currents of water some notable deposits of gold dust and magnetite occur, associated on account of their approximate specific gravity, on the bars and riffles of the water courses.

GLACIAL STRIÆ.

At two localities, direct, positive evidences of the ice flow, recorded by the glacier itself, were observed. Near the residence and on the farm of Jesse Winters, a band of hard, compact, oolitic limestone occurs, which, exposed by denudation at points nearly a mile distant, showed that over that area, and probably a much larger one, the glacier had, in its motion, leveled the surface, planing and polishing the solid rocks. The well marked striæ in a right line indicate the direction of this local flow to south 8° east

On the north bank of Coal creek, three miles west of Waynetown, the massive conglomerate forms the low banks of the stream, and is quarried for building purposes; the surface exposed for about half a mile on the Brant farm has been leveled and planed by the same agency, cutting across the lines of deposition. The direction of the striæ is more nearly in accordance with the great glacial movement down the valley of the Wabash and its tributaries, and is to south 18° east, with an apparently greater easting at other localities.

LACUSTRAL AND FLUVIATILE DRIFT.

The central, western and southern parts, as indicated from facts already mentioned, are as a rule covered with modified Glacial, Lacustral or Fluviatile drift, with true boulder clay at intervals. As might be expected from the mode of its origin and deposition, it contains a large amount of calcareous material from the underlying shales and local limestones. Water draining through this soil and gravel is highly charged with minerals. The great springs which flow out at the foot of the terrace gravel beds, deposit masses of calcareous tufa (honey-comb limestone). A film precipitated each day soon covers exposed objects, and a never-ending variety of leaves, grasses, twigs and mosses are preserved as casts. In proportion to the quantity of lime thus added the soil is enriched. The surface gently undulating is carpeted with shrubs and blue grass. The oak and elm forests which prevail on the cold tenaceous clays are replaced with a thrifty growth of ash, beach, walnut, poplar, sassafras and sugar trees of superior size. In autumn, when the frost just touches the ripening foliage of the latter, as if by magic, they are at once arrayed in festive robes of glory. The forest becomes a giant parterre, brilliant with a thousand vivid tints of purple, gold and crimson, relieved by a setting of russet and azure, while the emerald carpet is flecked and strewn with drifting leaves ripened to the deepest hues of orange, brown and vermillion. We may well suppose that the citizens of this county rejoice in this thanksgiving scene painted by God's own hand; and absorbing transfigured inspiration, her theologians and orators have spoken words that have deeply molded human character; that her poets in *alt* and *bass* have sung songs that have touched responsive chords wherever the English language is spoken.

GENERAL GEOLOGY.

The rocky exposures of this county belong to the Carboniferous age, and comprise the lower or conglomerate

member of the coal measures and the whole of the Sub-carboniferous period. Bores and wells of a 100 feet in depth have pierced the black slate or upper member of the Devonian age. Brought together in connected section from isolated and widely separated outcrops, they give the following stratigraphic exhibit:

CONNECTED SECTION, MONTGOMERY COUNTY.

		Ft.		Ft.	In.
	QUATERNARY PERIOD.				
1.	Alluvium	0	to	20	00
2.	Fluviatile drift and terraces	0	to	80	00
3.	Lacustral beds	0	to	50	00
4.	Glacial drift	10	to	120	00
	CARBONIFEROUS AGE.				
	CARBONIFEROUS PERIOD.				
	Coal Measure Group.				
5.	Conglomerate sand rock, heavy bedded or massive	10	to	80	00
6.	Shaly sandstone, with much false bedding, containing trunks, branches and prints of coal plants	2	to	8	00
7.	COAL A, rash and impure, changing to a black slate from 4 to 20 feet thick	8 in	to	0	00
8.	Shaly sandstone and pyritous shales	7 ft.	to	4	00
	SUB-CARBONIFEROUS PERIOD.				
	Chester Group.				
9.	Chester limestone	4	to	20	00
10.	Chester sandstone and shale	40	to	10	00
	St. Louis Group.				
11.	St. Louis limestone	12	to	0	00
12.	Yellow ferriferous sandstone	15	to	2	00
	Keokuk Group.				
13.	Keokuk sandstone	20	to	10	00
14.	Shales, with dykes and irregular pockets of limestone, rich in fossils	20	to	40	00
	Knobstone Group.				
15.	Knobstone shales and sandstone, without fossils	30	to	20	00

DEVONIAN AGE.

Hamilton Group.

16. Black slate in wells and bores	110	00
	574	00

The oldest strata out-crop at the extreme northeastern corner of the county, and are deposited with much regularity, dipping gently to the southwest. Following the line of dip along the valley of Sugar creek, the latter and higher beds are met successively, capped by the conglomerate member of the coal measures, near the county line, in the extreme southwestern corner. Hence, commencing at the lowest geological beds, we constantly ascend to superior and more recent strata, although, by actual levels, we are descending along the great inclined plane which gently slopes west to the Mississippi, the axis of the great valley of the continent. Reference is made to the general section by the marginal numbers.

DEVONIAN AGE.

BLACK SLATE.

The rocks of this age were not seen in place. They outcrop in localities immediately adjoining to the north and east, where their characteristics are well exhibited. Many fragments of the Black slate, No. 16, were seen in the drift near Darlington, and it is pierced in wells. A bore put down at Stover's mill, northeast quarter, section 29, township 19, range 4, found the black slate rich in bitumen, and almost carbonaceous, with a thickness at neigboring localities of one hundred and ten feet. This bed is distinctly and regularly laminated, is of dark, almost black color, when fresh from the quarry, but upon exposure, weathers to a brown or light gray. With partings and traces of asphalt, is associated much pyrite in sharp or obtuse crystals, known as "fools' gold." In adjoining regions this bed contains many minute marine fossils, as *Lingula*, *Discina*, *Leiorhyncus* etc., with bones and teeth of monster fishes, especially sharks.

SUB-CARBONIFEROUS PERIOD.

KNOBSTONE SHALES.

The Knobstone beds, No. 15, are determined from stratigraphic reasons alone. They consist of thinly laminated shales and shaly sandstones, seen in the bluffs of Sugar creek where it enters the county. They are of little or no economic importance, although crystals and pockets of pyrites have often given illusory hopes of gold to the unskilled. No fossils were seen; the nature of the deposit indicates a shore line with inflowing streams, discharging impure water, which, with a muddy bottom, was not suited to the life of marine animals, or the preservation of their remains after death.

KEOKUK GROUP.

With the exception of the very small territory already described, and the portions hereafter to be noted, the rocks of the Keokuk group occupy the central area, extending in a broad belt from north to south across the county, covered in places by out-liers of the later rocks, which have, as a rule, been removed by glacial or fluviatile action. These beds are generally deeply covered with drift, and consequently exposures are only seen in the beds and bluffs of the water courses. They consist of dark and gray shales and soft sandstones containing pyrite and clays. The lamination is regular and generally thin, the intervals of quiet being marked by homogeneous or massive beds. Such periods of stable quietude seem to have been regularly broken. Dykes of limestone, probably deposited upon or thrown against the sides of bluffs which must have existed in the bottom of an ocean of great depth, traverse the softer beds from northwest to south, southeast, parallel with the strike of the rim to the northeast. These limestone dykes and pockets, although of no great extent, are extremely significant. As a rule they are followed, for a space of one-fourth to half a mile, or more, with a rapid accumulation of sea silt with disturbed talse bedding, the faces of which indicate

a great open ocean to the southwest, followed by periods of tranquility and new disturbances.

These phenomena, taken as a whole, seem to indicate a gradual upheaval of the shore line, parallel with what is termed the Cincinnati dome, continued at irregular intervals, which resulted in a continued silting up of the areas under consideration. A full connected view of the facts can only be obtained by following Sugar creek in detail; and such a trip will convince the watchful student that the apparent irregularities of the dip are unreal, and may, in a great measure, be explained by reference to slight oscillation and consequent silt beddings. The sedimentary clays and shales near, but not immediately above the limestone pockets, are rich in fossils. At favorite localities the bottom of the sea was crowded with life. Armies of Crinoids with strong stems 1 to 20 feet long, yet pliant with life and safely anchored to the solid bottom, lived in great communities in the deep dark waters. Their heads, a wonder of artistic beauty and ingenious mechanism, were supported and surrounded by strong arms divided into fringed fingers, which, elastic with vitality, served at once for defense, and at the same time, with prehensile instinct, grasped and sorted the food which sustained their strange and complicated being. Other animals of artistic structure and wondrous symmetry prevailed; minute coral insects, gasteropods intimately connected as food or otherwise with the reigning crinoids; brachiopods reached out their spiral arms loaded with tentacles; curled ophiurians twisted their snaky fingers about the crinoid bases, and star fishes lent their subdued rays to enliven the gloom of that watery night.

The beds comprise several families, many genera and species, and billions of individuals. For their determination some of the prominent American and European paleontologists have devoted years of time and much treasure.

The authorities of New York, Ohio and Illinois and different scientific associations, have, in the kindest spirit, expended large sums of money in the discovery and study

of this chapter of the globe's ancient history, and have published more than one hundred costly figures and a thousand pages of letter-press, in illustrating and illuminating this remarkably interesting and rich field of researeh. Coming with the taste of the "tree of knowledge" on their lips, they have boldly demanded of nature an explanation of her laws and rules, and stripping bare one of her mysteries, have opened a new book for the information of man.

Fossils from the crinoid beds of Crawfordsville now enrich the cabinets of most of the colleges and geological associations of the scientific world. Every year discovers new forms and reveals new secrets.

The following list, made out with the assistance of that veteran student and scientist, Prof. E. O. Hovey, and the most extensive worker, L. H. Cory, kindly revised as to arrangement and detail by Prof. A. H. Worthen of the Illinois and Prof. R. P. Whitfield of the New York survey, is given as a full if not complete enumeration of the fossils. It may be observed that there are many species and several genera as yet inedited, a duty which Indiana owes to science, and which it is hoped she will shortly fulfill by full paleontological reports sufficiently illustrated.

LIST OF FOSSILS

FOUND IN THE KEOKUK GROUP AT CRAWFORDSVILLE, INDIANA.

PLANTÆ.

ALGÆ.

Genus CAULERPITES, Sternberg.

Caulerpites, (Sp ?) resembles **marginatus** .... Lesquereux.

Genus CHRONDRITES, Sternberg.

Chrondrites Colletti .... Lesquereux.

LYCOPODIACEA.

Genus STIGMARIA ? Brongniart.

Stigmaria Hightoweri .... Krout.

ANIMALIA.

RADIATA.

CŒLENTERATA.

Genus AULOPORA, Goldfuss.

Aulopora gigas..Rominger.

Genus SYRINGOPORA, Goldfuss.

Syringopora, (Sp.?)..

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis Dalii..................................Edwards and Haime.

Genus AMPLEXUS, Sowerby.

Amplexus fragilis.. ....White and St. John.

ECHINODERMATA.

CRINOIDEA.

PLATYCRINIDÆ.

Genus PLATYCRINUS, Miller.

Platycrinus hemisphericus........................Meek and Worthen.
— **Yandelli**..............................Owen and Shumard.
— (inedited.)

Genus DICHOCRINUS, Munster.

Dichocrinus expansus............................Meek and Worthen.
— **ficus**..................................Lyon and Casseday.

ACTINOCRINIDÆ.

Genus ACTINOCRINUS, Miller.

Actinocrinus Humboldti..Troost.
— **jugosus**...Hall.

Genus ALLOPROSALLOCRINUS, Lyon and Casseday.

Alloprosallocrinus conicus..................................Troost.

Genus BATOCRINUS, Casseday.

Batocrinus Agassizi..Troost.
— **calyculus**..Hall.
— **Coreyi**..............................Lyon and Casseday.

Genus ERETMOCRINUS, Lyon and Casseday.

Eretmocrinus magnificus..................................L. and C.

Genus AGARICOCRINUS. Troost.

Agaricocrinus tuberosus......................................Troost.
— **Americanus**, Rominger (=**tuberosus**......Troost.)

CYATHOCRINIDÆ.

Genus CYATHOCRINUS, Miller.

Cyathocrinus poterium............................Meek and Worthen.
— **inspiratus**..L. and C.

Genus Barycrinus, Wachsmuth.

Barycrinus herculeus .... M. and W.
— **Hoveyi** .... Hall
— **arboreus** .... M. and W.
— **Lyoni** .... Hall.
— **multibrachiatus** .... L. and C.
— **stellatus** .... Troost.
— **magnificus** .... M. and W.

Genus Poteriocrinus, Miller.

Poteriocrinus Indianensis .... L. and C.
— **Coreyi** .... M. and W.
— **Hoveyi** .... M. and W.

Genus Scaphiocrinus, Hall.

Scaphiocrinus æqualis .... Hall.
— **decadactylus** .... L. and C.
— **depressus** .... M. and W.
— **nodobrachiatus** .... Hall.
— **robustus** .... Hall.
— **unicus** .... Hall.
— **Coreyi** .... M. and W.
— (sp. ined.)

Genus Zeacrinus, Troost.

Zeacrinus concinnus .... Meek and Worthen.
— (sp. inedt.)

Genus Synbathocrinus, Phillips.

Synbathocrinus Swallovi .... Hall.
— **robustus ?** .... Shumard.

Genus Goniasteroidocrinus, L. & C. = ? Gilbertsocrinus, Phillips.

Goniasteroidocrinus tuberosus .... L. and C.
— (sp. inedt.)

Genus Forbeseocrinus, DeKay and LeHon.

Forbeseocrinus Meeki .... Hall.
— **Wortheni** .... Hall.
— **Saffordi** .... Hall.
— **? ramulosus** .... L. and C.

Genus Onychocrinus, Lyon and Casseday.

Onychocrinus exsculptus .... L. and C.

Genus Taxocrinus ?, Lyon and Casseday.

? Taxocrinus ramulosus .... L. and C.

(Family uncertain.)

Genus Catillocrinus, Troost.

Catillocrinus Bradleyi .... M. and W.

Genus Calceocrinus, Hall.

Calceocrinus Bradleyi .... M. and W.
— **nodosus** .... Hall.

BLASTOIDEA.

Genus PENTREMITES, Say.

Pentremites Wortheni .... Hall.
— **conoideus ?** .... Hall.

Genus GRANATOCRINUS, (Troost,) Hall.

Granatocrinus granulosus ? ....

ECHINOIDEA.

PERISCHOECHINIDÆ.

Genus LEPIDESTHES, Meek and Worthen.

Lepidesthes Coreyi .... M. and W.

Genus ARCHÆOCIDARIS, McCoy.

Archæocidaris (sp. inedt..) ....

Genus MELONITES, Owen and Shumard.

Melonites (sp. inedt.) ....

ASTEROIDEA.

Genus ONYCHASTER, Meek and Worthen.

Onychaster flexilis .... M. and W.

Genus PROTASTER, Forbes.

Protaster gregarius .... M. and W.

EDRIOASTERIDÆ.

Genus AGELACRINITES, Vanuxem.

Agelacrinites squamosus .... M. and W.

MOLLUSCA

MULLUSCOIDEA.

BRYOZOA.

Genus ARCHIMEDES, Le Sueur.

Archimedes Owenana.

Genus FENESTELLA, Miller.

Fenestella (sp. inedt.)

Genus TREMATOPORA, Hall.

Trematopora (2 sp. inedt.)

BRACHIOPODA.

Genus STREPTORHYNCHUS, King.

Streptorhynchus crenistria=
Hemipronites crenistria* .... Phillips

*In a letter in reply to questions asked Prof. R. P. Whitfield, the distinguished Paleontologist, at Albany, New York, says: "The genus HEMIPRONITES, Pander, as typified by *Orthis hemipronites* and *O. adspectus* is as yet unknown in America, and is distinct from STREPTORHYNCHUS, King, as recognized in *S. crenistria*."

GENUS CHONETES, Fischer.

Chonetes planumbona..M. and W.
— (sp. inedt.)

Genus PRODUCTUS, Sowerby.

Productus magnus..M. and W.
— **(tenuicostus) cora**..D'Orbigny.
— **punctatus**..Sowerby.
— **vittatus**..Hall.
— **alternatus**..........................Norwood and Pratten.
— **semi-reticulatus**..Martin.

Genus SPIRIFER, Sowerby.

Spirifer striatus..Miller.
— **Keokuk**..Hall.
— **fastigatus**..M. and W.
— **sub-orbicularis**..Hall.
— **sub-cuspidatus**..Hall.
— (sp. inedt.)

Genus ATHYRIS, McCoy.

Athyris Royissi..L'Eveille.
— **? sub-lamellosa**..Hall.

Genus RETZIA, King.

Retzia Verneuilanum..Hall.

Genus RHYNCHONELLA, Fischer.

Rhynchonella sub-cuneata..Hall.

Genus TEREBRATULA, Llhwyd.

Terebratula hastata..Sowerby.
— (sp.?)

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus AVICULOPECTEN, McCoy.

Aviculopecten Indianensis..M. and W.
— (n. s.)..Whitfield.

Genus MYALINA, De Koninck.

Mayalina Keokuk..M. and W.

Genus PINNA, Linnæus.

Pinna sub-spatulata..M. and W.

Genus LITHOPHAGA, Lamarck.

Lithophaga lingualis..Phillips.

Genus ALLORISMA, King.

Allorisma (sp. ined.).

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras fissurella..Hall.
— **infundibulum:**.......................................M. and W.
— **uncum**..M. and W.
— **equilatera**...Hall.

Genus EUOMPHALUS, Sowerby, or STRAPAROLLUS, Montfort.

Euomphalus (sp. inedt.)

Genus LOXONEMA, Phillips.

Loxonema (interior cast, inedt.)

Genus DENTALIUM, Linnæus.

Dentalium primarium..Hall.

Genus CHITON, Linnæus.

Chiton (sp.?)

Genus BELLEROPHON, Montfort.

Bellerophon (sp.?)

PTEROPODA.

Genus CONULARIA, Miller.

Conularia sub-carbonaria...................................M. and W.
— **Crawfordsvillensis**......................................R. Owen.

CEPHALOPODA.

Genus ORTHOCERAS, Breynius.

Orthoceras (sp. inedt.)

Genus NAUTILUS, Linnæus.

Nautilus Coxi...M. and W.

Genus GONIATITES, DeHaan.

Goniatites (sp. inedt.)

ARTICULATA.

CRUSTACEA.

Genus PHILLIPSIA, Portlock.

Phillipsia (Griffithides) **bufo**...................................M. and W.
— **seminifera ?**...Morrison.
— **Portlockii ?**..M. and W.

The principal fossil localities are at Corey's Bluff on the northwest bank of Sugar creek, a mile north of Crawfordsville, from which a majority of these fossils were obtained, at and near Troutman's mill, at and near the mouth of Lye creek, at Mrs. Dice's on Walnut creek, at and near the mouth of Offield and Indian creeks and on Black creek,

all within a radius of seven miles of the city; and the best localities are within three miles.

ST. LOUIS GROUP.

The St. Louis beds succeed in order of superiority. In the southern part of the State they present a heavy laminated or massive limestone, sometimes concretionary and full of fossils, from 100 to 200 feet thick, with slight beds of sandstone. Going north, the limestones become thinner and are more or less replaced with arenaceous material. Here the group is greatly reduced or entirely absent, and the usual fossils are extremely rare. A few weathered specimens of *Lithostrotion Canadense* are reported with *Pentremites conoideus, P. Woodmani, Zaphrentis spinulosa, Retzia Verneuilanum, Rhynchonella mutata, R. subcuneata, Euomphalus sp.? Waldheimia sp.? Spirifer incrassatus, Productus punctatus, P. (tenuicostus) cora,* with dissevered plates and stems of crinoids and sharks teeth. The above fossils were found at three different localities; one at the county line southwest of Parkersburg, at Oldshoes quarry west of Waveland, and at Coal creek quarry a mile west of Waynetown.

At places, if not generally, the rocks of the St. Louis group are absent or replaced by a sandstone without fossils and from the scanty evidence at hand, we may almost conclude that the conditions necessary: clear, pure, cold water, was episodal, subject to interruptions by and perhaps a recurrence of circumstances again suited to Keokuk life.

CHESTER GROUP.

The rocks of the Chester group exhibited a thickness of about 50 feet to the north, in Warren county, and of nearly 100 feet in the southern part of the State. Here they are greatly narrowed, ranging from 4 to 50 feet thick. They consist of non-persistent bands, dykes and pockets of gray argillaceous limestone, underlaid by a gray or yellow sandstone, well laminated, and gray and dark siliceous shales. The whole series is generally arenaceous and furnishes good

quarry stone at several localities northwest and west of Crawfordsville.

The line on the map indicating the "eastern line of the Chester beds" includes the most easterly outliers, and at the same time large areas in which such rocks have been eroded, exposing the underlying St. Louis and Keokuk strata.

The most abundant fossils are survivors from the Keokuk beds, which afterward give character and culminate in the coal measure epoch, as *Productus punctatus* (*vittatus*), *P. semireticulatus*, *P.* (*tenuicostus*) *cora*, *Hemipronites crenistria*, *H. crassus?*, *Spirifer striatus*, *S. lineatus*, *Athyris ambigua*, *A. subtilita*, *Terebratula bovidens*, *Retzia vera*, *Rhynchonella Osagensis?*, *Pinna Sp.?*, *Allorisma Sp.?*, *Aviculopecten* (*n. s.*), *Orthis resupinata*, *Dentalium primarium*, *Pentremites pyriformis*, *P. obesus?*, *Zaphrentis spinulosa*, *Syringopora* and *Archimides Owenana*.

The rocks of this bed both lime and sandstone are quarried, and at several localities furnish excellent material for foundations, cellar walls, piers and other hammered masonry. The limestone has been burned, yielding a strong "hot" lime.

CARBONIFEROUS PERIOD.

COAL MEASURES.

The coal measure rocks comprise a narrow belt along the western boundary; just touching the northwest corner, the area is much widened to the south of Alamo and along the bluffs of Sugar creek, and again reduced by denudation in Raccoon valley.

Coal A is here a thin, inconstant, impure seam of no value. For analysis see chemist's report. The coal varies in thickness from a mere trace to three or four inches; is generally absent, or at other localities diffused by maceration through from six to twenty-one feet of black argillaceous shale.

At this horizon several poorly preserved trunks of *Lepidodendra*, *Stigmaria* and *Calamites* were observed with

broad striated leaves of *Cordaites borassifolia*, with the fruits or nuts *Trigonocarpum olivæformis*, *T. ornatum*, *T. tricuspidatum*. and the berry like nuclei of *Trigonocarpum* and *Cardiocarpum*, some of which are probably new to science.

MILLSTONE GRIT.

The conglomerate sandrock superimposes the horizon of coal A, and is the highest, geologically, and most recent rocky bed in the county. It is a coarse, reddish brown sandstone, generally ferruginous, and at very rare localities containing white and red quartz pebbles. It is heavily laminated or massive, and exhibits a thickness from naught to 80 feet. It presents a valuable stone for heavy masonry, comes soft from the quarry but hardens on exposure to the air, and in the best beds is fire and water-proof.

To the foregoing description of the general section, details will now be added for local information.

LOCAL DETAILS.

Crawfordsville, the county seat, is located on a high bluff on the south side of Sugar creek, and because of its elevated position and natural drainage, effected by the underlying beds of sand and gravel, it is noted as a healthy city. The streets are wide, carefully graded and graveled, and shaded with native trees which render salubrity to the air as well as beauty to the city. The residences are neat and tasteful, and wear an air of thrift and comfort. Several manufacturing establishments, under judicious management, are prosperous and profitable. The city is also the commercial centre of the county.

The clayey nature of the soil rendered good roads both an economic and social necessity, resulting in the construction of nine first class gravel roads radiating from the common centre to the following places:

GRAVEL ROADS.

To Alamo	8 miles.
To Waynetown	12 miles.
To Pleasant Hill	6 miles.
To Concord, northeast	5 miles.
To Darlington	6 miles.
To Fredricksburg	6 miles.
To Parkersbnrg	3 miles.
To Waveland	6 miles.
To Hill's Factory	3 miles.
To Ladoga and Ashby	4 miles.
	59 miles.

This makes a total of 59 miles of gravel roads in the county which has cost an average of $1,500 a mile or $88,500 for the whole, which were constructed by private corporations, under the gravel road laws of 1872. Many of these roads were found to be in excellent condition, and so remain the year round, especially that portion which is constructed of hard glacial pebbles with only enough sand to fill the interstices. It has been found here that small pebbles make the best road, and that a hard clay bottom requires much less gravel than other soils. In the absence of gravel beds, sand has been used for metalling some of the roads on a tough clay soil, under the impression that in time it would "pack" and become solid.

The beneficial influence of these roads is great and can be fairly appreciated by those only who remember the sloughs, morasses and "corduroy" in and on which the public were tortured in their travels thirty years ago. They open new sources of income and economy to the people, appreciate the adjacent property, and give vigorous impulse to social enjoyment and mental improvement.

WABASH COLLEGE.

At an early date in the settlement of the west, when the pioneer had just entered the wild forests, still occupied by wilder savages, a band of young missionaries, hopeful for the future of this region, and foreseeing its moral and

educational needs, determined to found a school for collegiate education. Like knights of chivalry or standard bearers of a forlorn hope, they laid their plans, staked off the grounds, and kneeling on the snow that frosty November morning, consecrated themselves to the enterprise, and it to the God of Heaven. The vow then taken, with the enthusiasm of young manhood, has been fulfilled with signal devotion and untiring energy. Its founders taught and worked on a salary of six hundred dollars a year, but with the spirit of martyrs they returned one half to the treasury of the college, gave one hundred dollars to other charities, and reserved only the meager sum of two hundred dollars on which to feed and clothe themselves and families. In determination and self-denial "there were giants in those days."

With kindred feelings for *Alma Mater*, it is pardonable to make special mention of the writer's preceptor in geology, Prof. E. O. Hovey, as a christian gentleman, a hero in the educational cause, to whose prayerful faith and steadfast courage, which, like Sheridan's, could pluck victory from fiery disaster, this college owes its success if not its existence.

Wabash College was founded in November, 1832, and has been sustained entirely by private munificence. She has sent forth nearly 300 graduates, given high educational advantages to about 2,000 young men and her annual catalogue contains from 200 to 250 names. Her sons have gathered honors both in peaceful pursuits and in war. The last words to me of one of her bravest, Maj. David Shelby, who died for his country, in blessing his *Alma Mater* were: "I thank God I was reared in the land of the Yankee School Master."

The college edifices are situated on a beautiful campus of thirty acres covered with native forest trees. They consist of a chapel hall containing recitation, society, lecture, cabinet and library rooms; a dormitory with accommodations for one hundred young men; an academic hall for the

preparatory department and the military department, gymnasium and school of Technology.

"The course of study is full and thoroughly pursued, so that Wabash College has acquired high reputation and richly deserves, as it has, the confidence of the public."

In a great measure this county owes its mental, moral and pecuniary advancement to the unseen and hardly realized influences of the college which has, with full hand, thus blessed and rewarded its friends.

The terrace bluff, upon which Crawfordsville is situated, is composed of fluvatile gravel and sand, washed and sorted from the glacial drift and lacustral sands and silt, underlaid by some hummock-like masses of undisturbed bowlder drift. These terrace beds contain a large admixture of the pyritous argillites from the Keokuk and Knobstone shales, which, on exposure, are decomposed, and becoming soluble, give origin to a number of chalybeate springs, locally known as sulphur springs, some of medicative repute. At freshly denuded beds, copperas, (sulphate of iron), may always be detected as a frost-like efflorescence. The ancient valley and river was probably in the extreme southern part of town, and, being obstructed in the direction of its discharge, formed a basin that was puddled and made capable of holding a vast body of water at a very early period; afterwards this basin was filled with pervious sand and gravel, still leaving a large capacity for water. Washes and ravines cutting the rim of the basin, drain off this water and afford discharge to the magnificent springs in Whitlock's hollow, which was the original attraction that caused this point to be settled by agents of the General Land Office. A few years since the rim of the basin was tapped by the wash in the bluff, between Washington and Vernon streets, giving outlet to a rushing, roaring torrent of water. Wells on the College Hill have pierced this terrrece bed to a depth of nearly 100 feet, without reaching the bed rock, and show that the ancient valley was excavated to an equal or greater depth than the present channel of Sugar creek.

At the deep gorge in the north part of town the following strata were observed:

SECTION AT CRAWFORDSVILLE.

	Ft.	In.
Fluviatile and modified drift	18	00
Dark clay with boulders	8	00
Buff lacustral sandy clay, with fine pebbles and pockets of sand	9	00
Blue clay with striated and planished boulders, with pockets of clay and sand to Sugar creek	42	00
	67	00

The crinoid locality owes much of its notoriety to Prof. E. O. Hovey who has published articles describing the bed and its contents. Especial mention is due to O. W. Corey who justly claims the discovery of some of the best localities and who, with Mr. E. H. Corey, by their persistent explorations, have done so much for science. In honor of the former, his name is given to the bluff, southwest quarter, section 29, township 19, range 4, now owned by Prof. Bassett, where the best finds are met:

SECTION AT COREY'S BLUFF.

One and a half miles north of town, just below railroad bridge.

	Ft.	In.
Soft gray sandstone with crinoid stems and *Producti*	10	00
Shaly sandstone, without fossils	10	00
Ferruginous parting, *Pentremites*	0	06
Soft gray sandstone	5	06
Blue argillaceous sandstone	3	00
Blue siliceous clay shale, in places filled with crinoids and many other fossils, crinoid bed	4	06
Gray ferriferous sandstone	2	00
Blue shaly soapstone filled with fragmentary fossils, interrupted by an inclined dyke of limestone	25	00
	60	06

A majority of all the animal remains found in the list heretofore given, page 376, are found at this station, therefore a special list is unnecessary.

Similar fossil beds are found in the bed of Walnut creek, northeast quarter, section 11, township 18, range 4; at the

mouth of Black creek, southeast quarter, section 34, township 19, range 5; on a brook southeast from Troutman's mill, near the center of north half section 3, township 18, range 5; at the mouth of Offield creek, south half, section 16, township 18, range 5, and at the mouth of Indian creek, southeast quarter, section 2, township 17, range 6.

At each of these stations thin beds or dykes of limestone, generally steeply inclined, cross the creek valleys irregular as to thickness, but parallel with the line of strike of the rocks. The face or dip of such beds is toward the center of the basin, but an exception was seen where two such beds formed an anticlinal, capping the top of a former sub-marine bluff. These limestones contain remains of many shell-fish, disconnected crinoid joints, etc., but rarely or never crinoid heads or star fishes. It is probable that the stems were here anchored and remained, but at some tida current, the heads being lighter, were swept away and buried with the sands and clays of the same specific gravity.

The different families of crinoids, with their companion parasites or dependents, seem to have lived somewhat in communities, although at roughly deposited stations, many species irregularly mingled are found.

From a condensed list of the specimens in the unrivaled collection of the college cabinet, and some private parties, the following gives an approximate estimate of the numercial ratio.

Actinocrinus	Indianensis	6
Actinocrinus	Humboldti	1
—	jugosus	2
Agaricocrinus	tuberosus	4
Alloprosallocrinus	conicus	2
Batocrinus	Agassizi	11
—	calyculus	2
—	Coreyi	1
Baryculus	herculeus	2
—	Hoveyi	2
—	Lyoni	2
—	arboreus	7
—	stellatus	2
—	magnificus	6
—	multibrachiatus	5

Cyathocrinus poterium	2
— inspiratus	1
Catillocrinus Bradleyi	1
Calceocrinus Bradleyi	1
Dichocrinus ficus	5
— *expansus	2
Eretmocrinus magnificus	3
Forbeseocrinus Meeki	19
— Wortheni	1
— Saffordi	2
— ramulosus	14
Goniasteroidocrinus tuberosus	5
Onychocrinus exsculptus	12
Poteriocrinus Coreyi	2
— Hoveyi	1
— Indianensis	2
Platycrinus hemisphericus	25
— Yandelli	1
Scaphiocrinus æqualis	23
— decadactylus	10
— depressus	1
— nodobrachiatus	1
— robustus	1
— unicus	9
— Coreyi	1
Synbathocrinus Swallovi	1
— robustus ?	1
Taxocrinus ramulosus	14
Zeacrinus concinnus	1

Just above the mouth of Walnut creek, a thick bed of dark shaly clay, homogenous and regularly laminated, seems to have been the result of quiet waters. No fossils were seen. Still ascending Walnut, on the farm of W. H. Durham, an interesting lot of fucoides and other fossils were seen.

SECTION AT DURHAMS'.

	Ft.	In.
Soil and gravel	30	00
Soft shaly sandstone	15	00
Blue shaly soapstone	6	00
Blue pyritous sandstone, with *Algæ*, *Producti*, *Spirifera*, *Chonetes*, *Zaphrentes*, etc., geodized	3	00
Blue shale, with vermiform fucoides	7	00
	61	00

The *Zaphrentes* were strangely irregular in shape, strangulated, and all the geodized fossils were largely magnified in the process of silicification. On the same land, near the abandoned saw mill and factory, is a perpendicular or overhanging rock known as Mt. Pisgah. Several well preserved fossils were seen, including *Spirifers*, *Chonetes*, *Producta*, *Phillipsia*, *Conularia*, and a single specimen of *Lithostrotion proliferum*.

At the "Devil's Backbone," a short distance above the confluence of Walnut with Sugar creek, the former closely approaches and is separated from the latter by a narrow foot-path. It is a favorite pic-nic ground. The local dip is to the northwest about 20 feet per mile.

SECTION AT DEVIL'S BACKBONE.

(Northeast quarter, section 29, township 19, range 4.)

	Ft.	In.
Clay and gravel	8	00
Gray shaly sandstone	4	00
Blue siliceous shale, with fucoides	4	06
Pyritous shale, place of upper crinoid bed	2	06
Blue shale with plates of sandstone, to creek	10	00
	29	00

A short distance above, is the old seat known as Stover's mill, northeast quarter, section 29, township 19, range 4. Here was formerly a deer lick, much frequented by wild animals. Many bones and horns of deer, buffalo, elk, etc., have been found, washed out by the creek which flows near by. The "lick" water comes from the base of a pyritous shale, and owes its saline-tonic qualities to the decomposition, by exposure, of the pyrite which sets free soluble iron and sulphur, the latter combining with the clay to form alum, sulphate of alumina.

About forty years ago, Major I. C. Elston put down a bore here for salt water to a depth of 75 feet. On reaching the black slate forty feet below the surface, it was found to be somewhat bituminous, and at the same time supposed to be coal, although full 140 feet below the horizon of the

lowest seam, A, and 210 feet below any workable coal. In 1867 another test bore was made which fully settled the question. No coal was or can be found at this level.

SECTION AT STOVER'S MILL.

	Ft.	In.
Clay and loam	18	00
Terrace and drift	22	00
Gray sandstone and shale	24	00
Buff shale	14	00
Blue pyritous shale	14	00
Sandstone, shale and thin limestone in bore	70	00
Black slate in bore	10	00
	172	00

At the iron bridge one mile west of Crawfordsville, the top of the high bluff is built up with regularly laminated beds, but the limestone plates and pockets near the water level are irregular, dipping in every direction, indicating rather the result of a destructive storm wave than regular sedimentary deposits. This presumption is confirmed by the crushed, broken and disjointed condition of the crinoid stems and other fossils. The following section is seen:

SECTION AT IRON BRIDGE.

	Ft.	In.
Covered soil and drift	11	00
Soft sandstone, with *Productus cora*, and *P. semireticulatus*	8	00
Gray shale and shaly sandstone	19	00
Blue and gray heavy bedded sandstone, with plates of limestone	11	00
Blue shale, with *Forbeseocrinus*, *Platycrinus*, *Spirifer striatus*, *Producti*, etc	4	06
Red or blue ferruginous limestone, with crinoid stems, *Productus punctatus*, *Platyceras*, and *Chonetes planumbona*	1	06
Blue soapstone, to low water in creek, with crinoid plates and stems, *Producti*, *Spirifera* and *Athyris lamellosa*	4	00
	59	00

A short distance above the bridge, on the south side of

the creek, is seen the ancient erosion of the ice age crossing the present channel and valley of the creek with striæ corresponding in direction with those seen at the Horse shoe, (Durham's farm), on Walnut branch, viz: south 22° west; both places are now filled with a mass of boulders capped with lacustral silt. The violent washing process that sorted these huge boulders, ground and pulverized some of the crystalline rocks, and considerable quantities, more than fifty dollars worth, of gold dust and magnetite have been "panned" out by amateur collectors, on the ford bar. The lacustral silts at this place, below the foot of Washington street, and where the Green Spring gravel road crosses Dry branch, contain many trunks of large trees, vines, etc., indicating the warm subtropic climate that prevailed during this period. Fragmentary remains of tropical animals are preserved in the same beds, and teeth and bones of the *Elephas Americanus* (American Elephant) are not uncommon.

At Remly's bluff, one and a half miles west of town, a perpendicular bluff of drift guards the south bank of the creek. It affords an interesting exhibit of the agencies at work during the Quaternary period. In the upper fluviatile drift was found some well preserved bones of the lately extinct monster, the Mastodon. At Remly's ford, on the north side of the creek, was seen an interesting fossil bed, though they were generally fragmentary. Planished rocks covered with striæ, that were uncovered by the floods of 1875, were seen on the south bank of Sugar creek, a half mile above the railroad bridge at Troutman station. Mammilary knobs and protuberances finely striated record the direction of the flow to south 8° east, almost perpendicular to the present river valley.

Above and below Troutman station, many springs, of volume, sufficient to turn a mill, burst out from the side of the bluff. They demand for their origin a vast sponge of gravel and sand capable of absorbing and retaining for a time the rainfall, all contained in a vast trough or basin. We have already seen that the agencies, working in cross

direction at different periods of the glacial epoch, would necessarily produce the results here apparent. The water is heavily charged with lime in solution, which is precipitated on exposure to the air. Extensive beds of calcareous tufa are formed, in which are preserved casts of leaves, mosses, grasses, twigs, etc., in a flim of lime, thickened by constant accretions.

Tufaceous deposits have, in some measure, been adopted for chronological purposes, in discussions on the antiqutу of man and animals. By assuming a certain number of centuries as necessary for the formation of one inch of tufa and the acute use of multipliers, the age of man can be extended back indefinitely. Learned and labored arguments, founded on such uncertain assumptions, have been given to the world, hence definite facts throwing light upon the subject are of deep importance. Mann's (Winton's) mill erected at the early settlement of this county, was fed by the lime-water spring just north of Troutman's mill. The machinery was driven by an overshot wheel ten feet in diameter; its use was discontinued in 1835. In 1847 I saw the wheel imbedded in tufa up to the axle; now, 1875, the whole wheel is covered by this material. Supposing the accretion to have been continuous, irrespective of drought or floods, there has been a bed of tufa deposited on and about this water wheel, ten feet thick in a period of less than forty years, or three inches a year. A stalactite, formed against the exposed rocks by a wet weather seep, may be seen at the "stone cut" a short distance south of Bedford, Lawrence county, Indiana, on the line of the Louisville and Chicago railway. This deposit had attained a thickness of four inches in a period of twenty two years, requiring nearly six years to the inch.

Abram Troutman's mill utilizes the whole water of Sugar creek because of the solid limestone floor on which the dam is placed. It has three run of buhrs, two of which are driven, without fail, during the year. A short distance above, the bluff is composed of soft aluminous shale, which, a few hundred yards to the northeast, passes into a quarry

bed of sandstone. At the mill occurs a limestone reef nearly horizontal for a small space, composed almost wholly of crinoid stems and other relics of animal life.

SECTION AT TROUTMAN'S MILL.

	Ft.	In.
Drift and terrace slope.		
Gray sandstone	20	00
Shaly sandstone	25	00
Pudding stone limerock	10	00
Blue shale	4	00
Crinoidal limestone, mass of animal remains	7	00
Blue soapstone in creek	4	00
	70	00

The above limestone contains, with a vast amount of stems and joints of crinoids, a great number of shells, as *Productus*, *Spirifer*, *Platyceras*, *Hemipronites* and *Chonetes*, the animals that seem to always congregate or to have been gathered at localities where the crinoid stems were anchored to the rocky bottom. This occurrence is too often repeated to be the result of accident. Doubtless their companionship was of mutual benefit, or possibly the limited area of stony bottom compelled the life of the sea to lead a congregational existance. Within a short distance, this limestone thins and passes to a soft argillaceous shale or mud stone, and reappears highly inclined, after an interval of shaly beds, half a mile wide.. This discontinuance and recurrence of inclined bands is so often repeated as to form a law for these Keokuk beds, as was fully mentioned under the head of general geology.

At Cascade bridge, four miles southwest from town, a small brook leaps from an overhanging cliff twenty feet high and falls in a veil of ıoam. The water holds lime in solution, which precipitated, preserves in its stony film casts of leaves and moss. A tiny rainbow sometimes dances on the cloud of spray, and many a happy pair, after pic-nic visits here, have carried away bright images of that bow's promise on their hearts, forever.

SECTION AT CASCADE BRIDGE.

(Southeast quarter, section 3, township 18, range 5.)

	Ft.	In.
Surface loam with limerock	10	00
Yellow ferriferous sandstone	2	00
Soft shaly sandstone	25	00
Brown or reddish limestone in plates and bands, crowded with fragmentary fossils	5	00
Blue soapstone, filled with crinoid plates and joints, "button mold" wash	8	00
Blue soapstone, faced with calcareous tufa	20	00
	70	00

Yountsville is the centre of a rich agricultural region. From the first settlement of the county it was a notable wool carding and milling locality. Spring creek was then the source of power, driving a saw mill, two grist mills and a woolen factory. Thirty five years ago Daniel Yount commenced the manufacture of woolen goods, and has since, by utilizing the whole water of Sugar creek, built up an extensive business favorably known over a wide extent of country. He employs three sets of carding machines, four spinning jacks, twenty looms and a full set of finishing machinery. Average product, $75,000 per annum; during the war a single year's work amounted to $170,000.

An irregular pocket of limestone was seen at Snyder's mill in the village. A conglomeration of well preserved fossils crowded upon and within each other, among which were observed *Spirifer striatus*, *Productus semireticulatus*, *P. punctatus*, *P.* (*tenuicostus*) *cora*, *Chonetes planumbona*, *Hemipronites crenistria*, *Phillipsia bufo*, etc.

This bed dips rapidly to the southwest, passing to a siliceous firestone, the partings marked with casts of Chondrites and other fucoides, and like the limestone before noted, constant only in inconstancy.

Bald hill, a mile north of Yountsville, is a picturesque spot, by barometer 110 feet higher than Crawfordsville and 190 feet above Sugar creek, which washes its base. A fine view is enjoyed up and down the valley of the creek and its

tributaries. Four miles away the steeples of Center church, the City school house and Wabash college are plainly seen in relief against the blue sky. The top of the hill and adjoining knolls are covered with well assorted fluviatile sand and fine gravel; plainly indicating the high water line of the ancient river which flowed by here to the west before its course was obstructed by the glacial flow and ice dam from the north.

At Hemlock bluff, less than half a mile below the village, there is a good exposure of strata, giving one of the best sections in the county.

SECTION AT HEMLOCK BLUFF.

	Ft.	In.
Sandy loam with hemlocks	33	00
Siliceous limestone, with *Spirifera* and *Producta*	4	00
Blue carbonaceous shale	4	06
Red ferruginous limestone, with *Spirifera*, *Producta*, plates of crinoids, *Pentremites conoideus*, *Nautilus Coxi ?*, and *Trilobites n. s.*	2	06
Concretionary sandstone	6	00
Blue and gray shale, with plates of sandstone, the partings marked with vermiform fucoides	75	00
	125	00

Continuing to descend with the stream, the limestone, just noted, near the top of the bluff and 80 feet above the creek, at the mouth of Offield creek approaches low water and is seen as two pockets, the first is 60 feet wide and 5 feet thick in the middle with wedge shaped terminals to northeast and southwest; the second, 150 feet wide and 15 feet thick, similarly wedged out. Both are crowded with a conglomerated mass of crinoid stems; enough remains to have constituted millions of individuals. The stems were disjointed, and in many cases crushed as if a burial ground, on which their descendents lived, flourished and perished when some tidal wave swept away their plumed heads and feathery armatures, leaving the heavier stems with the *Producta*, *Spirifera*, *Platyceras*, etc., who clung to the superior race or nestled at their bases. The latter

shells, with bryozoans were but slightly injured or well preserved.

Clark's mill is driven by the whole power of Sugar creek. The dam is built upon a solid rock bottom, and is completely effective. It comprises a saw and grist mill, the latter with two run of buhrs.

From Clark's to Bodine's mill a blue siliceous shale and sandstone forms the bluff of the valley and apparently dips to the southwest, in localities, at the rate of 30 to 40 feet to the mile; but this dip is local and unreal and is rather the result of false bedding built up against eroded banks and irregularities in the bottom of the subcarboniferous ocean. The siliceous shales are probably equivalent to the St. Louis beds, judging from stratigraphic reasons alone, as not a fossil was found in place except the vermiform impressions attributed to fucoides which are seen continually from the bottom of the Knobstone throughout the whole subcarboniferous period and in the coal measures. The muddy bottom of this ocean and the impure nature of the water were not suited for animal life or the preservation of the remains as fossils.

Commencing at the top of the Hemlock bluff a mere layer and increasing to the southwest to a thickness of 20 to 40 feet at the "Shades of Death," is a soft, yellow, heavy bedded sandstone, which, for reasons similar to those just stated, and from close resemblance to the same beds in Orange, Lawrence, Owen, Putnam and Warren counties, are referred to the Chester group. This stone is well and regularly laminated, except where the strata are tilted against and over humps and ridges in the floor of the sea. It is generally argillaceous, weathers buff or gray, and contains many nodules or hollow balls of ironstone. A great many bluffs on this division of the creek guard the narrow valley with precipitous sides covered with clustered wreaths of beautiful evergreens.

Half a mile above Bodine's Mill the west bank presents a nearly perpendicular face, along which pebbles came leaping and bounding as if from an ambuscade of boys.

SECTION AT BODINE'S MILL.

	Ft.	In.
Yellow ferriferous sandstone, Conglomerate.........	30	00
Gray and buff laminated sandstone stained with iron, Chester and St. Louis..................	75	00
Silico-argillaceous shale, Keokuk..................	25	00
	130	00

On the Boo farm, half a mile north of the mill, pieces of float coal are washed out by the brook, and on the Ammerman farm adjoining, a small pocket of coal was opened, indicating the level of coal A. Descending with the stream, steep, rugged hills inclose the narrow valley, forming wild and romantic scenery.

Half a mile above the mouth of Indian creek, are the "Shades of Death." Clifty, a small brook, after turning upon itself, Sugar and Indian creeks at all points of the compass, flows into the latter forming a labyrinth of promontories, precipices and look-outs. The valley of the insignificant brook will not average over 100 feet in width, but is cut down into the soft, shaly sandstone to a depth of 140 feet. The sharp, narrow promontory is approached by a narrow causeway and ingress or egress is limited to a few favorable spots. On Indian creek the rocks are regularly laminated, but along the smaller brook the dip is quaquaversal. At the mouth of Clifty the upper rocks are heavy bedded or massive and ferruginous, weathering yellow or brown. The hard, ferruginous partings and concretions disintegrate more slowly than their rocky matrix and stand out in relief like magnified swallows and hornets nests, and are occupied in the nesting season by swarms of birds. The sides and slopes of these sharp hills and promontories are covered with a thick growth of evergreen hemlocks and cedars, and the tiptop hights with pines which lift their plumed foilage 200 feet above the brook, averting the sun's rays and filling the deep chasm with a gloom typical of the "valley of the shades."

Just below the mouth of Indian creek, the heavy bedded

sandstone comes down to the waters edge. A massive layer projects twelve feet, overhanging the deep channel 10 feet below. The sides retain the erosive moldings which record the ancient stand points of the stream. A symmetrically rounded buttress is a prominent feature and is known as the "pulpit rostrum."

Canine & Deer, on southeast quarter, section 2, township 17, range 9, secure the power of Sugar creek by a tight dam fitted to the solid rock bottom, to drive their saw and grist mill and woolen factory. The latter is supplied with the best new machinery and does a sale and custom business amounting to $20,000 per annum.

SECTION AT CANINE AND DEER'S MILL.

	Ft.	In.
Soil and gravel	15	00
Coarse, heavy bedded, Conglomerate sandstone	15	00
Black, shaly soapstone, (place of coal A ?)	3	00
Ferruginous Chester sandstone, honey combed with pockets and recesses in which swallows, martins and pewees nest	8	00
Concretionary sandstone, with ironstone nodules	45	00
	86	00

The Silver Cascade and Buzzard Rookery are a mile and a quarter below the mill, or five miles north of Waveland. Little Ranty, flowing from the south, approaches in a flume-like passway cut 50 feet deep in heavy sandstone, and thence rushes in a filmy sheet 45 feet down an almost perpendicular bank of dark shale, like an endless ribbon with warp of silver and woof of sparkling crystals. The cascade is nestled away in an amphitheater, 200 feet in diameter, crowded with shrubs, ferns and tenderest wild plants, here untrodden and unseen. Travelling ferns* creep over and cling to the ragged masses of tufa, which guard the narrow entrance from the eye of the careless observer. More than a hundred feet above, tall oaks and pines,

*_Camptosorus rhizophyllus_, Link, erroneously designated by the writer as _Lygodium_, in Ind. Geo. Rep. 1874, p, 236.

encircling the rim, swing their branches together across the cove and chasm.

The scene is worthy a visit by the stereoscopist for a view, equalling, in spring and winter, the wildest beauty of the mountains. At the "rookery" all the buzzards living within 10 or 15 miles, meet each summer evening for information, converse and mutual assistance. The fact is mentioned as an evidence of the social instinct of this bird.

From this locality west, the conglomerate sandstone caps all the elevated region outside of the valleys and forms the surface rock. A few unimportant outcrops of coal A were visited. They are insignificant pockets, in no place exceeding a few inches in thickness. It is hopeless to expect this or any other seam of coal to present a workable thickness in a region, so near as the rim of the basin, where coals, as a rule, are always thin and barren.

A list of the carboniferous fruits found on Col. Budd's farm, four miles northwest of Waveland, is already given in the description of the general section. At and near Scott's mills a very ungeological confusion of coal measure and subcarboniferous strata is seen on the west side of the creek. As the station is extra-limital, discussion is unnecessary.

Alamo is the most elevated point visited in the western part of the county. The citizens bear evidence of the salubrity of their vicinage in their stalwart frames and energy of character. From this place the drainage is to every point of the compass, by Sugar, Mill and Coal creeks and their tributaries. South of the village, obscurely parallel lines of low knolls, extending in nearly an east-west course, were observed, with depressions and shallow crevices intervening with spaces of from 80 to 150 yards. They are referred to the glacial age, and seem to indicate the time when the retiring ice foot rested against the elevated spot; each winters expansion pushed up the little line of mounds before the ice, which, melting in the summer, would leave depressions in the muddy surface. In the decadence of the glacier, the recession of summer always exceeded the winter thrust, hence it is possible that these

insignificant knolls may record, by the intervening spaces, the rate at which the glacier foot was annually withdrawn.

Adjoining the village to the north and east, were noticed some conical cavities of large size which were, probably, the remains of waterways, entirely filled up at the same period, with the exceptions now mentioned. These phenomena are worthy of more time and study than could be spared in a hurried examination.

In passing north from Alamo to Wesley, a remarkable set of valleys exist, evidently once the channel of a large stream, but now drained by small brooks. Some of these extend from the waters of Sugar creek across the divide, and connect with the branches of Mill and Coal creeks, while a great number suddenly terminate, obstructed or filled with boulder clay, covered with hard-pan silt. Barometric observations discovered two such outlets, which, the citizens inform me, were uninterrupted, and the highest elevation in which was not greater than the top of the terrace gravel on which Crawfordsville is built. Wells put down at several stations in these ancient valleys, pierced beds of sand, fine gravel and mucky clays, proving that formerly they were the channel of a rapid flowing river, now largely filled up. These valleys were formerly or are now morasses; one known as Wild Cat swamp is said to be an almost impassable quagmire. Another contains a lakelet of about 30 acres, known as Fruit's cranberry pond, in which wild cranberry vines still grow and yield good crops. The proprietor, Mr. George Fruits, was one of the pioneers in this region; he is now one hundred and nine years of age, and still retains his strength and faculties in a wonderful degree.

Waynetown is a thriving village situated on the south bank of Coal creek on the I., B. & W. railway. It is surrounded by a wide area of gently undulating land of loamy soil, rich in calcareous matter and remarkably fertile, producing extra crops of corn, wheat, oats and grasses. Clover makes unrivaled growth. The extraordinary condition of the soil is due to fluviatile currents, which, in former ages,

had passage over this region, sorting and modifying the boulder drift and enriching the residual material with calcareous detritus eroded from the limestone outcropping to the east and northeast.

The forests of stately poplar, walnut, oak, sugar tree, beech, etc, which once covered this region have generally given way to the agriculturist, but some fine groves survive to tell of their former greatness.

Going west from the village down Coal creek, the following strata are seen in outcrop within a distance of two miles; the lower rocks successively dipping and passing from sight beneath the higher and more recent beds.

CONNECTED SECTION AT WAYNETOWN.

	Ft.	In.
Soil and drift.......................... 10 to	50	00
Conglomerate sandrock..........................	25	00
Place of coal A—shale..........................	8	00
Chester shale..........................	12	00
St Louis limestone in bed of creek, near town..........	3	00
Siliceous shale..........................	7	00
	105	00

The above limestone contains a few characteristic St. Louis fossils, as *Pentremites conoideus*, *P. Woodmani*, *Spirifer striatus*, *Rhynchonella mutata*, *Zaphrentis spinulosa*, *Aulopora gigas?*, *Euomphalus lævis*, a *Conularia* with disjointed stems and plates of Crinoids and a few shark's teeth.

The Conglomerate sandrock is well developed just beyond the county line. On the farm of C. Brant, two miles west of the village and a half mile south of the railway track, a bed has been opened which presents an excellent white, gray and buff sandstone, fire and weather proof, and worthy the attention of builders, for piers, foundations and strong hammered masonry. This bed ought to command a switch from the railway, as it would be advantageous in reconstructing the road, and probably add largely to its freight

trade. The top of this (Brant) quarry stone, for a quarter of a mile along the creek, has been planed to a level surface by glacial action, and presents one of the best examples of this grand phenomena, of the ice age, that may be seen in the State. The planished surface is marked with delicate striæ, recording the direction of the flow.

The northern part of the county is notably a prairie region deeply covered with boulder drift; no rocky outcrops are visible. The prairies are level or gently rolling and are skirted by forests and dotted with island groves. In a state of nature the great plains, covered with rank waving grass and wreathed with vernal flowers of every hue, was a scene of grandure and beauty. Now the scene is changed and invested with higher practical interest. The whole expanse has been brought under cultivation or laid down in grass. With a soil that under forty years close cropping still exhibits no lack of fertility, the cereal productions rival those of the most favored localities. The soil is especially adapted to the growth of grasses and grazing, and the farmer of the future will give greater attention to this, the most profitable branch of agriculture. The neat towns and cross-road villages in the prairie region, indicate the thrift and prosperity of the inhabitants.

Linden, on the Louisville & Chicago railway, already puts on city airs in the completeness of its shops and residences. It is surrounded by beautiful, broad prairies, in which great corn and wheat fields, and meadows and grass lands, dotted with white cottages and stately mansions may be seen in every direction. In the western suburb is a chalybeate spring. The drainage water, in passing through beds containing pyrites, takes up the iron in solution, which on exposure to the air is deposited as flocculent sediment of brown and red ochre. The village is almost directly on the great trail or dyke of boulders which may be traced a long distance to the northwest, and is a constant feature in a southeasterly direction. On knolls and ridges the ground is covered with rounded masses, one to four feet in diameter, of black or red crystalline rocks, imported on the glacial

raft, from the extreme north. At depressions and valleys, the boulders are less numerous, although the trail is still plainly discerned, hinting the possibility that such depressions contained sufficient water to float the ice which dragged slowly and with much resistance over the higher knolls.

The phenomena observed in relation to Lye and Black creek swamps, are mentioned under the head of recent geology. It has been determined by a line of levels, that a cut of only eight feet would return the drainage of these swamps to their ancient channel, via Black creek. Wells put down in these swamps pierce the following lacustral beds without finding bottom:

SECTION IN LYE CREEK SWAMP.

	Ft.	In.
Peat and muck	3	00
Yellow clay	2	00
Quick sand—silt	10	00
	15	00

Darlington is one of the most considerable villages in the county. It is located upon a gently rolling bluff on the south side of Sugar creek, and on the line of the Logansport and Southwestern railway. The citizens are intelligent, energetic, and noted as firm friends of education and progress.

The higher divides between the streams are composed of unmodified glacial drift. Such clays are cold, tenaceous, and require underdraining for profitable growth of the cereals, but are well adapted to meadows. The terrace plains along the streams and creek bottoms are very fertile. Large forests of valuable oak timber survive, which are prepared for market by the mills that abound on Sugar creek. They are an important source of income. The boulder trail, already mentioned, passes just west of the village. It is an interesting feature in the surface deposits of this region. Fragments of Devonian black slate are frequently met in drift, and in a well sunk on Dittemore's farm, it was reported found in place. On Asa Dittemore's

land, northeast quarter, section 7, township 19, range 3, a thin Keokuk limestone was quarried for the piers of the Darlington bridge. The following strata were observed:

SECTION NEAR DARLINGTON BRIDGE.

	Ft.	In.
Soil and drift	25	00
Limestone, hard, ferruginous	0	08
	25	08

Lye creek flows into Sugar creek a few miles below town. The bed of the stream is upon blue and gray shales and sandstones of the Keokuk age, in which a few interesting fossils have been found. Ascending Lye creek a short distance, the eastern bluff contains a thick band of laminated yellow and red limestone, which is quarried for foundations. The following strata were noted:

SECTION NEAR MOUTH OF LYE CREEK.

	Ft.	In.
Sunface loam	6	00
Yellowish red limestone, containing *Productus cora*, *P. punctatus*, *P. muricatus*, *Spirifer striatus*, S. (indt.) crinoid stems and plates, disjointed, and fish teeth	9	00
Blue and green siliceous shale with *Zaphrentis* —, *Loxonema*, and *Euomphalus*	8	00
	23	00

Ascending Lye creek, on Isaac Rich's land, southwest quarter, section 1, township 19, range 4, is an outcrop of quarry limestone four to eight feet thick. Beneath it, some twelve feet, are a number of those pockets or dykes (here of sandstone) which were considered characteristic of the Keokuk beds, and as indicating the mode of their deposit. These dyke bands are from four to eight feet thick with strike from northwest to southeast, but only 30 to 60 feet wide, and are evidently the result of tidal waves sweeping up the shelving bottom of the ocean whose shore line was to the northeast and here, breaking on the bottom.

SECTION ON LYE CREEK.

(Rich's Farm.)

	Ft.	In.
Soil, etc	5	00
Crinoidal limestone, ferruginous, laminated	8	00
Gray shaly sandstone	12	00
Dyke pockets of sandstone in blue shale, 0 feet to	8	00
Blue aluminous shale	4	00
	37	00

Just above, the creek passes over a floor of limestone inclined so as to partially dam the stream. Many crystalline rocks and boulders are seen in the channel at this point, and on the land of Mrs. J. Naylor, Mr. Edwin Cadwallader has collected several dollars worth of gold in flat scales, each pan showing "color." The shales in the low bank of the creek are crowded with fossils in nests, showing well preserved *Productus*, 3 sp., *Spirifer striatus*, valves of *Hemipromites crenistria*, three inches long, with *Chondrites*, *Caulerpites*, and vermiform fucoides.

On the farm of Jesse Winters, same section, the bed of Lye creek is strewn with a wonderful number of giant boulders; great, black, horneblendic monsters are heaped up with white granitic masses of crystalline rocks, which give in epitome the story of the glacial age, and explain the great thickness of the ice mass that could tear such rocks from their quarry-beds in the distant Arctic regions and transport them over a thousand miles to this spot, and the irresistable power which ground, planed and polished such obdurate materials, like mere trifles in the hands of a giant; for many of the boulders are from five to eleven feet in diameter. Still more explicit is the story told by the deeply covered native rocks. Wherever exposed by stripping, it is found that all the surface rocks over an area of miles, was plowed down, leveled and polished by the ice. Fine striæ, plain and delicate, as if the work of yesterday, point out accurately the direction, south 8° east, of the flow. Letters and words could not speak more intelligently. It is the finger of God recording on the

rocks forever, the wondrous story of nature's re-constructive and reparative agencies used in preparing a barren world of rocks for occupancy by animated nature.

The Keokuk limestone on this farm is oolitic, or composed of myriads of minute concretions like the roe of fishes and so compact as to perfectly preserve the evidence of the glacial phenomena. By the kindness of Mr. Winters and his son Jonathan, we were enabled to see these phenomena at widely separated stations and under favorable circumstances.

SECTION AT WINTER'S FARM.

(Oolitic limestone bed.)

	Ft.	In.
Soil and fluviatile drift	5	00
Glacial drift, with polished boulders and gravel	10	00
White Oolitic limestone, with many crinoid stems and plates, and *Athyris Royissi, Hemipronites crenistria, Productus punctatus, P. cora. Spirifer striatus, S. Wheeleri?, Platycrinus Saffordi, and Synbathocrinus robustus*		06
Blue ferruginous limestone with same fossils and *Syringopora*		06
Siliceous limestone, red	1	06
Irregular yellow sandstone	4	08
Blue shale	2	00

The boulder trail already mentioned is a very prominent feature in the topography of this neighborhood; in some places the great rounded masses are thickly strewn, so as to almost cover the ground, in a band from a quarter to a half mile wide, and in many places show such uniformity in appearance as to suppose a common origin from the same quarry bed. At several stations wells have been put down in the trail, generally finding, at a depth of 10 to 20 feet below the surface, a bed of silted quicksand. This is especially the case at depressions in the surface, and seems to indicate that at such places the ice was floating as bergs in the water at the time the boulders were cast off.

According to the bores put down at Stover's mill, before mentioned, the Devonian black slate ought to be found

near the bed of the streams in this part of the county. In John Hewlet's well, on southeast quarter, section 8, township 19, range 3, several fragments of this rock were found and examined. The level clay lands between Lye and Sugar creeks were originally covered with a heavy growth of oak timber. The soil is compact and tenaceous, and may be greatly benefited by underdraining.

The valley of Walnut creek is wide and contains a large area of rich and highly productive land. It is a valley of erosion and owes its origin to the excessive precipitation which occurred about the close of the glacial epoch, when all our creeks were rivers. A tell-tale monument, of this time and the concurring phenomena, exists in the shape of a sharp conical mound, two miles west of Shannondale. It is situate on the Sutton farm, northwest quarter, section 34, township 19, range 3, in the midst of the broad valley plain of an insignificant brook, and is 90 by 100 feet in diameter and 40 feet high. It is symetrical in shape and sharply conical. The boulders on the summit and sides, show that it once was part of the great glacial drift, which at one time covered the surrounding region, as deep or deeper than the mound is high, but since eroded, save this mass.

Beckville is situate on the flat, level summit of the glacial drift. The soil of this region is black and often mucky; the drainage is by the south branch of Walnut into Sugar creek. The village is on ground 95 feet higher than Crawfordsville.

Valley City, or New Ross, is a bright, gay village on the I., B. & W. railway, at the crossing of the proposed Anderson & Lebanon railroad, already graded. The eastern side of the county is generally level or slightly undulatory; the surface slopes gently, without bluff, to Walnut and Raccoon creeks. It was originally clothed with a magnificent growth of forest trees, including black walnut, poplar and oak of from three to six feet in diameter. Since the completion of the railway the timber from single acres has been sold at from 30 to 70 dollars. The most valuable trees are gone; some white and burr oaks survive, with much sugar,

beach, elm, linden, sycamore, cottonwood and willow. The soil is due to fluviatile action, and is generally enriched by a large admixture of lime from the underlying rocks, long since torn and ground up by water courses. It is fertile, and produces good crops of grain. The grasses delight in this soil and grow with unrivalled vigor.

At a cut on Squire Jessee's farm, exposed by the recent floods, the thread-like roots of blue grass were observed fringing the bank and which had penetrated the warm soil to a depth of two and even three feet. A short distance north of the village, on the land of J. B. Jessee, southwest quarter, section 36, township 18, range 3, the Keokuk limestones are exposed in the bed of Raccoon creek, and are quarried for foundations, etc. It is compact, almost wholly of crinoid shells, conglomerated together in wonderful profusion and confusion, with *Spirifer striatus*, in nests, and *Producta*, *Hemipronites* and *Platyceras*. Notwithstanding the immense number of crinoid stems, amounting to billions of individual crinoids in a single acre, the heads of the animals and the tiny light fingers and tentacles were almost wholly removed; but a single head of *Platycrinus Saffordi*, was found.

On the some farm, half a mile below, a lower bed of argillaceous limestone, about two feet thick, is quarried for building purposes. It contains the same fossils found in the upper bed, but in better preservation, indicating that the animals had lived and died on the spot, and had not been subject to the wear and tear of transporting agencies. A valuable bed of excellent gravel was here seen. It is a treasure for road making, and insures to the vicinity the social refinement, civilizing influences and prosperity, consequent upon good roads. Descending with the creek to the southwest, on the farm of Isaac Baker, northeast quarter, section 3, township 17, range 3, the upper crinoidal limestone was the low bluff of the creek. The stone is a mass of disjointed stems of crinoids slightly cemented together in a confused mass, from 6 to 9 feet thick. This innumerable host gives a hint of the vigorous life that thronged the

ancient sub-carboniferous ocean, below whose waves these rocks were formed. In the adjoining bed of the stream a blue argillaceous limestone is quarried, containing fine specimens of *Spirifer striatus*, *Hemipronites crenistria*, *Productus punctatus*, *P. cora*, *P. semireticulatus*, *P. costatus*, *Platyceras equilatera*, and *Aulopora gigas*. A short distance below, at the old mill dam, beds of shale and argillaceous sandstone replace and cover the foregoing limestones. All the rocks just mentioned and seen exposed in a space of two miles and a half along Raccoon, brought together in vertical section, give the following stratigraphic exhibit:

SECTION AT VALLEY CITY.

	Ft.	Ft.	In.
Soil	20 to	10	00
Argillaceous sandstone	0 to	3	00
Crinoidal limestone	3 to	9	00
Blue argillaceous limestone	2 to	4	00
Blue shale, in creek		10	00
		36	00

The crinoid limestone is composed wholly of animal remains, and the possible presence of the phosphate of lime would suggest the use of this stone, after burning, for manure. The amount of phosphorus may be only a small per centage, but it is found that even homeopathic doses of this mineral have a powerful sanitary effect upon the soils.

Ladoga is one of the most prosperous villages in the county—the buildings are in good repair and well painted, and the gardens and grounds neat and tastefully adorned with shrubs and flowers, indicative of an orderly, intelligent and happy community. Several superior stone and other business houses indicate a well sustained trade, while churches and subtantial school houses prove that the mental and moral training is not neglected. It also contains saw, grist and planing mills, shops for the manufacture and repair of wagons, carriages, agricultural implements, etc. The large woolen mills of Harney, Thomas & Co., are propelled by a steam engine of 80 horse power, with surplus steam

for dying and scouring. The machinery consists of two sets of wool carders, two spinning jacks and fifteen looms with the complementary apparatus for making flannels, jeans, cassimeres, blankets, broadcloths, etc. Their fabrics are honestly made and justly bear a good reputation. Their annual product is $30,000 to $40,000.

The country is still ahead of the town. The farms are well arranged and on every hill and knoll are seen white cottages or stately mansions which rival in comfortable appointments, our city residences. All these are but an index of the sure returns awarded to the industrious husbandman by the rich surroundings. The soil is a deep calcareous loam and produces, with certainty, good crops of wheat and corn but is especially suited to the growth of the grasses. The native blue grass is a mine of safe reliance; in a few years it forms a dense sward, and in product, equals the most favored region. This country was originally covered with a splendid growth of large walnut, poplar, ash, beach and sugar trees. The forests have been utilized or destroyed, giving place to productive fields and pastures. Some of these giants of the forest survive, crowned with the frost and glow of nearly a thousand years; and right royal do they appear in their massive strength and prominence that has so long defied time and storm; many groves of sugar, beach, poplar, etc., are preserved, and, at the time of my fall visit, no scene in fairy-land could exceed the brilliant beauty of their foliage, the leaves, ripened by the mellow warmth of autumn, had been just touched by frost, and blushing, wreathed the sober hues of nature in a quivering vail of colors borrowed from the rainbow. The scene was of enchanting interest, and the sight would fully pay the cost of a visit by European tourists who, in their own land, may not enjoy such specimens of nature's painting.

A short distance east of town is the first rocky outcrop exposed between that place and the old mill dam near Valley City. At the railroad bridge the following exposure is noticed.

SECTION AT RAILROAD BRIDGE, LADOGA.

	Ft.	In.
Soil and drift	8	00
Gray shaly sandstone	18	00
Blue argillaceous sandstone in heavy beds	4	00
	30	00

At the wagon road bridge, about ten rods west of the last mentioned locality, a strange and sudden change occurs in the stratification, indicating the versatile and inconstant nature of the ancient sea that deposited these rocks, and which, considering the regular lamination of the surrounding strata, may not be intelligently explained without calling in requisition a strong tidal wave of great velocity sweeping up against shore line shallows, or driving up an estuary or bay with current and force sufficient to carry coarse sand and pebbles. Intercalated with the ordinary rocks is a bed or dyke of pebbly conglomerate, eighteen inches thick, but which wedges to sharp edges within a width of thirty feet, crossing the valley from north to south with the strike of the rocks.

CONGLOMERATE SECTION AT LADOGA.

	Ft.	In.
Soil and drift	6	00
Gray shaly sandstone	12	00
Pebbly conglomerate	0 to 1	06
Blue pyritous sandstone, with fucoides, in creek	4	00
	23	06

Similar beds of shaly sandstone were seen on the farm of Daniel Graybill, northeast quarter, section 27, township 17, range 4, five miles southwest of town. No fossils were seen except the common vermiform fucoid. The blue shales contain much pyrites, which on exposure decomposes and incrusts projecting rocks with an efflorescence of copperas (sulphate of iron). The same mineral, mixed with earth and gravel, produces chalybeate sulphur springs.

The site of the former Indian village, north half, northeast quarter, section 34, township 17, range 4, known as "Cornstalk town," was visited. In 1828 a remnant, some 20 families, of the great Miami nation dwelt here and cultivated in corn and pumpkins a field of 14 acres. On old maps the great war trail, from Vincennes to Thorntown and the Mississinewa, passed through this spot. Chief Cornstalk was a brave, faithful friend of the whites, and was respected and obeyed by his tribe. The kindest relations existed between the races. The white children were frequent and welcome visitors, enjoying the hospitality, sports and chase of the Indians, and were held in such kind remembrance that after an absence of 30 years they were at once recognized and hailed as brothers by their old friends in their new western home.

A dividing ridge from 100 to 150 feet higher than Ladoga, separates the water shed of Raccoon from that of Indian creek. The ridge is well marked, with often a sudden depression on either side. At several places mentioned by Col. J. H. Harney, the northern and eastern slope exhibits a shore line containing wave-washed sand and gravel. To the north and west, occupying an area of 40 or 50 square miles in the centre of the southern part of the county, is the level basin inclosed by the shore line ridge. The surface shows a black mucky soil, resembling that of the grand prairie of the western part of the State. It is level or very gently undulating, so that, in the first settlement of the county, it was, in parts, known as the "Black Swamp.,' Going northwest, toward the centre of the basin, several other shore lines of sand are reported, marking where the retiring water line was, for a period, stationary. The wells are shallow but penetrate beds of quicksand, fine gravel and mucky silt, containing trunks and branches of trees, all more or less laminated and so plainly the result of deposits from still or currentless water, that its lacustral origin seems obvious. Acknowledgements are due to Col. Harney, for much information and for facts in relation to these phenomena, who first

called attention to, and has investigated the subject with care. The containing ridge at the south, near Raccoon, is a sharp and narrow reef of limestone, which, during the later period of the drift, was sufficient to retain and deflect the rain fall of this basin by Indian creek to Sugar creek and the west.

Parkersburg, near the south line of the county, being without facilities for transportation, is a still and quiet village. The highest hills and ridges are capped with lime and sandstones of the Chester group. Near the water level in the brooks and creeks are plates and bands of some thickness containing a few characteristic fossils of the St. Louis limestone, while in the bed of the streams Keokuk rocks generally prevail. The limestones of each group are largely thickened up, compared with those in the northern part of the county, giving room to "sink-holes," so constant a feature in the southern part of the State, where these rocks are so grandly developed. They, in turn, receive and concentrate the rain-fall, giving rise to pure springs. An example is seen in the centre of the village, which supplies the citizens with pure, cold water.

The southern part of this and adjoining parts of Putnam county are specially adapted to the growth of blue grass. It is settled by an energetic class of Kentuckians, who have devoted large areas to the growth of this favorite grass. They delight to call their Indiana home "New Kentuck," and fondly hope to assure old associations by forming a new county with the familiar name of Bourbon, so full of pleasant memories.

The southwest part of the county is a broad valley plain, with gently undulating or rolling surface, drained by Big and Little Raccoon and their numerous tributaries. In the course of the long period in which these creeks have been engaged in excavating their thoroughfares in this water-shed, they have naturally traversed and modified nearly the whole surface deposits of this plateau; consequently the soil, a strong calcareous loam, is equal if not superior to any in

the most favored spots in the county, and rewards the farmer with full crops and sure returns. Waveland, on the Logansport, Crawfordsville and Southwestern railway, near the crossing of the proposed Lebanon, Anderson and St. Louis railway, is the trading centre of this district, and as might be expected, fully reflects the wealth and prosperity of its tributary district, in return. The village, with citizens strongly imbued with puritanic rectitude, has exerted a conservative moral influence, by example as well as precept, on the surrounding community. Good schools, good churches and general intelligence are characteristic. The Waveland Institute has given thorough academic instruction to many of our best college graduates. Temperance is absolute; for the title of town lots is guarded by wholesome covenants forbidding the traffic in intoxicants, under the penalty of forfeiture. Two miles southwest from the village is a thin outcrop of Chester and St. Louis rocks on the McIntire and Milligan farms. These beds are quarried by stripping, to supply the local demand for cellar walls, foundations, etc.

SECTION NEAR WAVELAND.

(Connected.)

	Ft.	In.
Soil and glacial drift	25	00
Eroded fragments of conglomerate and quartzose fire-clay	4	00
Laminated limestone, with *Zaphrentis spinulosa*, *Productus cora*, *P. punctatus*, *Spirifer striatus*, *S. lineatus*, *Athyris ambigua*, *Hemipronites crenistria*, *Chonetes*, *Pleurotomaria*, *Syringopora*, crinoid stems and branches of ferns	3	00
Blue, hard limestone, with *Bellerophon lævis*, *Retzia vera*, *Pentremites conoideus*, and a radiate, inedt	2	00
Blue shale	4	06
Sandstone at Jarvis'	2	06
Shale	7	00
	48	00

The new radiate in the foregoing section was kindly presented to the writer by Mr. Z. M. Ball, druggist. It is

unique, and though not sufficiently cleaned for determination appears to be related to the genus *Melonites*, but more closely allied to *Oligoporus* or *Lepidesthes*, and is probably generically and specifically new. The state of preservation is unusual, for even the small spines or tentacles which cover the interambulacreal plates are well preserved.

Passing down Little Raccoon, the cherty limestone quarried at Milligan's is seen in the bank and bed of the stream. It is remarkable for frequent variations in its quality and physical constitution, changing first to siliceous limestone, then to sandstone and finally passing into heavy-bedded limestone, with intercalations of chert, as at Oldshoe's quarry.

SECTION AT ROBERT OLDSHOE'S QUARRY.

	Ft.	In.
Soil and drift	6	00
Blue and gray Chester limestone in laminæ, with *Pentremites pyriformis*, *Productus cora*, *P. punctatus*, *Spirifer striatus*, *Zaphrentis spinulosa*, Bryozoans well preserved and many *Syringopora attenuata*	10	00
Soft buff calcareous sandstone passing into limestone	9	00
Heavy bedded, cherty, white and gray St. Louis limestone, with *Retzia vera* *Waldheimia*, *Rhynchonella mutata*, *Euomphalus lævis*, etc	5	00
Rumpled, blue, clinky limestone with *Syringopora* in reefs	3	00
	33	00

At the county line, on the farm of Capt. Jacob Oldshoe, is seen the junction of the conglomerate sandstone with the subcarboniferous rocks. The following outcrop was observed:

SECTION AT CAPTAIN OLDSHOES'.

Southwest quarter, section 32, township 17, range 6.

		Ft.	In.
Soil		15	00
Gray, white, yellow and striped conglomerate		25	00
Irregular, false bedded conglomerate		5	00
Place of coal A			
Aluminous shale with pockets of *Kaolin* (Indianite)	0 to	1	06
Good hematite	0 to	2	00
Aluminous shale	3 to	0	00
Laminated limestone with partings of clay		15	00
Siliceous clay		2	00
Heavy bedded gray and white limestone with *Zaphrentis*		6	00
Laminated limestone in plates, to the brook		2	06
		74	00

Several beds of good iron ore (hematite) were visited on this farm and specimens secured for analysis. The Kaolin, on chemical test, proved equal to the best, and, although the bed seen is not considerable, further search for this valuable porcelain clay is invited by this presentation, as it is found in extensive deposits, at this horizon, in other parts of the State.

ARCHÆOLOGY.

The general absence of earth-works in a productive region like this county is significant. It indicates that the social instincts of the Mound Builders located their permanent towns and villages only on streams susceptible of navigation by canoes, etc., and allows the presumption that in this remote period the shute at the canyon-like "Narrows of Sugar creek" was an obstacle too dangerous for this quiet and peaceful race to brave. One mound of doubtful origin was seen in the valley, in the west part of Waveland, and a cluster of low mounds was mentioned by J. M. Rice, Esq., on the north bluff of Sugar creek where it finally leaves the county. These, if true mounds, are only exceptions to the general rule—no mounds. Yet the

evidence of the presence and possession of this region by our earliest predecessors is full if not complete. In about every part of the county implements and ornaments wrought in stone are found, cut in good style by the most skillful artisans of the "Mound Builders age." In the cabinets of Rev. F. M. Symmes and Dr. T. D. Brown, were seen grooved stone axes with handle guards in relief, flint arrow and spear points and knives, gorgets, shuttles, pendants (plumb-bobs), spinerets, pipes, pestles, chisels, awls, five duck "totems" and one seal or Manatus "totem."

ECONOMIC GEOLOGY.

Lacustral and fluviatile drifts so largely prevail, that they give character to the soil of this district. These loams, enriched by admixture of local limestones, vary in constituents, and furnish soils well adapted to all the needs of a prosperous agricultural community, and which fully compensates for lack of mineral wealth. There are small areas of waste land that only require tile draining to render them immensely productive. Wheat is the principal cereal cultivated, but fair crops of corn and oats are produced, and the growth of forage plants may be equaled, but rarely excelled. After long years of cropping the original fertility of the soil may be restored in a few years by setting in clover. The apple, pear and quince are successfully grown and yield winter fruits in abundance. The small fruits, "native and to the manor born," are of superior quality and easy culture.

SCHOOLS.

Education has commanded the thoughtful consideration of some of the best minds of the county. Free schools are maintained in every neighborhood. All the towns and many of the villages have high schools and academies of good repute, affording facilities for a high grade of education, and Wabash College, with its extensive library, unrivalled geological and mineralogical cabinet, complete philosophical and chemical apparatus, years of experience

and large endowment fund, presents opportunity for a thorough collegiate course.

MANUFACTURES.

As yet the manufacturing industries are in their infancy, but a salubrious climate, cheap food, cheap homes, accessible coals and a ready market invite the attention of artisans.

WATER POWER.

The streams are fed by perpetual springs, and a fair supply of water may be relied upon, even in seasons of drought, with full supply for more than half the year. At least one half of this valuable power remains unused.

MEDICINAL SPRINGS.

Springs of great volume are not unfrequent. The chalybeate springs within the corporate limits of Crawfordsville have long been in use by the citizens, and their curative properties are well attested. They act as a laxative, febrifuge and tonic invigorator. Analysis by Dr. Thad. M. Stevens, of Indianapolis, found the following minerals in a pint of water:

Vandeave's Mineral Spring.

	Grains.
Carbonate of potassa	0.018
Carbonate of soda	0.021
Carbonate of magnesia	0.473
Carbonate of iron	0.077
Carbonate of lime	1.225
Chloride of sodium	0.088
Sulphate of soda	0.025
Sulphate of magnesia	0.915
Silicic acid	0.009
	2.846

Carbonic acid and oxygen gases are held in solution which render the water agreeable to the taste.

GRAVEL FOR ROADS.

Man is a social being, and the full enjoyment of these instincts demand facilities for intercommunication. There can be no full realization of civilization and Christianity without good highways, passable at all seasons of the year. The bond of union that sustained the Roman empire and civilized its subjects was its system of good roads that centered at the capital from every land. This county is supplied with vast beds of gravel, sorted by fluviatile action from the glacial drift, and is the best material known for road making. It should be utilized.

BUILDING STONE.

Limestone suitable for foundations and walls is found at irregular intervals; the quantity is limited and the quality inferior. The conglomerate sandstone, massive and heavy bedded, is grandly exhibited along the western side of the county. This stone comes soft from the quarry, but hardens on exposure; may be readily split or broken as desired by the workmen, and is fire and weather-proof. Blocks of any magnitude within the possibility of transportation may be obtained. Some of the beds south of Alamo and west of Waynetown contain good grits suitable for grindstones. A stone offering so many valuable qualities should be developed.

CLAY.

Clay for bricks may be obtained in every neighborhood in the county. Other clays suitable for common crocks and jugs have been worked with satisfactory results, and examination has discovered deposits suitable for the manufacture of drain tile.

TRANSPORTATION.

This county is favored with a pretty complete system of railways, which, crossing at Crawfordsville, radiate north, south, east, west, northeast and southwest. At least four other connecting lines are proposed, with some prospect for

their completion, one of which will place the city of Crawfordsville in direct communication with the coal fields of Fountain county, and give a decided impetus to manufacturing enterprise.

THANKS.

Thanks are returned to the citizens generally for kind assistance and co-operation in the survey. Acknowledgements are due to the following persons for hospitality and special favors: The President and Professors of Wabash College, Hon. H. S. Lane, Col. S. C. Wilson, Hon. P. S. Kennedy, R. K. Krout, Mr. T. D. Brown, F. M. Symmes, Dr. and Mrs. E. O. Hovey, Prof. Bassett, Col. Jas. H. Harney, Henry Campbell, Mrs. J. P. Campbell, O. W. Corey, Prof. J. M. Naylor, J. M. Rice, Esq., Jesse Winters, Dr. J. Naylor, Jonathan Winters, H. Darnell, Miss C. Troutman, Gen. M. D. Manson, L. H. Corey, James Heaton and others.

GEOLOGY

OF THE

SOUTH-EASTERN PART OF CLAY COUNTY.

BY JOHN COLLETT.

By instruction, my examinations in this county are limited to that part lying contiguous to and adjoining Owen, embracing township 11, range 6, the fractional townships 9, 10 and 12, range 6, and township 12, range 5, comprising 138 square miles, or 87,920 acres.

Eel river enters this region near the northeast corner, and after passing in a southerly course for about 12 miles, bends west in a great circle through the centre of the county, returning to cross in the southern extremity of the district under consideration. Birch creek crosses the extreme northwest corner, flowing to the southwest. These streams are increased by a multitude of smaller creeks and brooks, affording ample drainage and stockwater. The general features of the whole county have been given in Prof. Cox's First Annual Report, 1869, to which reference is made. The present report will consequently be restricted to developments made since that time.

GLACIAL EPOCH.

The entire area of this county is covered to a depth of from 10 to 100 feet with original or modified glacial drift. Some of the most remarkable phenomena of that time are here exposed to view or developed by bores made in search of coal.

The general erosion of the rocky strata is apparent, shaving off a broad area from north to south through the centre and western parts of the county, and from the east by Jordan and Six-mile creeks. A bore put down in the valley of the latter by Mr. Markle, commencing at the horizon of coal A, and near the actual low water of that stream, proves that in the earliest days of the Glacial drift, its valley was subject to a vast current of water from the east, cutting it down to a depth which can only be explained by assuming a corresponding or greater depth for valleys to south and west, now filled up to a general uniform level, viz:

SECTION AT MARKLE'S BORE.

(Southeast quarter, section 33, township 11, range 5.)

	Ft.	In.
Erosion in actual valley	64	00
Development in bore	70	00
	134	00

A similar bore put down by Jno. R. Langford (to whom we are indebted for the following record) on southwest quarter, section 35, township 10, range 7, was commenced on the bank of, and within ten feet of low water in Eel river, and gave the following unexpected result:

SECTION AT LANGFORD'S BORE.

	Ft.	In.
Loam	9	00
Quicksand	4	00
Coarse gravel	8	00
Quicksand	32	06
Black clay (silt)	1	00
White quicksand	6	06
White sandstone (float)	3	00
Gray quicksand	6	00
Float coal		06
Shaly shingle	14	03
Green sand	6	00
Float coal		02
Coarse quartz pebbles	2	07
	93	06

Bores on Splunge creek, near the centre of the reservoir, showed quicksand and gravel as far as tested, one to a depth of 45, another of 117 feet. Of course, these are only "old river channels," of limited width, and certainly having a still greater unknown depth, as not one test was made to the bed rock. The origin of this erosion, taken by itself, is inferential, but its reference to the ice period is reasonable and well supported by general facts. It is with pleasure that we can now justify such inferences with positive and direct special evidence—the rocky records inscribed by the glacial graver on tablets of living stone, and conclusive in themselves.

GLACIAL STRIÆ.

In the southeastern part of Bowling Green, and a quarter of a mile east of town, a spur of conglomerate sandstone obstructing the direct flow of the glacier, it was compelled to pass around or rise over this rocky dam. In the latter case it barely mounted the ledge 90 feet high, removing the upper member of that bed, planishing and striating the massive division. Inequalities in the hardness of the stone show by the talus behind each ferruginous concretion the direction of the flow; the striæ give the exact course; the rounded slope tells of the propelling power behind, which could drive the ice up hill against the slope, and finally the level planished surface at the summit sharply ground down indicates the thickness and the immense weight of the glacial mass; as full and complete and easily interpreted a record as we could hope after the lapse of many hundred thousand years.

The course of the marks, taken with a surveyor's compass, by Mr. Homer Hicks, is as follows: On southeast quarter of northeast quarter, section 19, township 11, range 5, the large and well defined striæ point south 26° 31′ east; the smaller ones south 30° 35′ east; on the southeast quarter of the northwest quarter, of same section, south 30° 40′ east; on northwest quarter of southwest quarter, of section 35, township 11, range 6, well defined marks were south 26° 30′ east, and those less distinct south 29° 30′ east. At J. T. Carither's farm, northeast quarter of

southeast quarter of section 6, township 11, range 5, is a small exposure with a flow up an ascending grade, striæ very distinct, south 26° 30′ east; on John Rockey's land, east half, section 1, township 11, range 6, are four exposures at one station; combined, they show an area of about 30 by 100 feet, planed to a level almost as smooth as if the work of man. The hard, ferruginous sand-rock retains the striæ in perfect preservation, fully as well as at the famous exposures on Kelly's and Put-In-Bay islands, so highly appreciated and so often visited by geologists. The course is south 36° 20′ east. At the precipitous bluff of the river, less than half a mile east, the conglomerate strata expose a thickness of 28 feet, with mouldings and water lines, fixing the ancient level of the river at its several stated points. On Geo. Rhode's farm, three miles south ,southwest from Bowling Green, is a good exposure extending over an area of 9 by 27 feet on the sandrock bluff, 20 feet, above Eel river, and just in front of his residence. Here, again, the flow was on an ascending grade of one in fifty; the surface well planed and the striæ distinct. The course, as reported by James Ferguson, is south 32° 10′ east. The foregoing facts are given especially for the benefit of "doubters" who so constantly ask positive evidence; the localities may be easily reached, and a visit will repay any one taking the least interest in science and the reconstructive agencies of the earth.

LACUSTRAL EPOCH.

The loess is seen in the western part of the district, especially in the valley of Birch creek, reaching nearly to Brazil, and constituting the soil of the prairie region. It is characterized, in addition to the common trees, by the growth found peculiar to this soil, viz: sweet gum, persimmon, birch, etc. The quicksands and silt reported in the mud bores may probably be referred to this age.

PALEOZOIC GEOLOGY.

The rocky exposures of this district comprise part of one

group of the sub-carboniferous, and the lower coal measures reaching up to the roof rocks of L and including two seams of block coal. These exposures, brought together from widely separated stations, have been tabulated in a connected section :

GENERAL SECTION, SOUTH-EASTERN PART OF CLAY COUNTY.

CARBONIFEROUS AGE.

CARBONIFEROUS PERIOD.

COAL MEASURE GROUP.

No.	Character of Strata.	Ft.		Ft.	In.
1.	Surface soil and drift	10	to	100	00
2.	Shaly soapstone	2	to	10	00
3.	COAL L	5	to	8	00
4.	Plastic fire clay	3	to	5	00
5.	Gray shale	1	to	3	00
6.	Red sandstone passing into cherty argillite	10	to	16	00
7.	Bituminous limestone passing to calcareous argillite	6	to	4	00
8.	Black sheety slate	3	to	4	08
9.	COAL K	1	to	4	00
10.	Fire clay.	5	to	4	00
11.	Gray shale and soft sandstone	20	to	28	00
12.	Blue shale	0	to	7	00
13.	COAL J	3	to	3	08
14.	Indurated clay	3	to	6	00
15.	Gray shale and soft sandstone	12	to	10	00
16.	Dark (black) shale	15	to	6	00
17.	COAL I	3	to	4	00
18.	Stony fire clay	20	to	5	00
19.	Gray shale, with iron ore space, very variable	90	to	12	00
20.	COAL B	1	to	3	00
21.	Soft conglomerate	10	to	20	00
22.	Massive comglomerate	90	to	40	00
23.	Dark aluminous shale, with iron ore	2	to	10	00
24.	COAL A	0	to	2	04
25.	Fire clay	1	to	4	00
26.	Dark pyritous shale, with iron ore passing into sandstone	4	to	20	00

SUB-CARBONIFEROUS PERIOD.

CHESTER GROUP.

27.	Kaskaskia limestone	10 to 22	00
28.	Chester sandstone and gray siliceous shales	27	00
		378	08

Beginning at the foot of the column, with the strata which occupy the lowest geological position but the highest relative level, we find a thin showing of the Sub-carboniferous period. The Chester is the highest group of that age, and here are only presented the upper members of that group. The Chester sandstone and shales, No. 28 of section, offers nothing valuable or of particular interest. The sandstone is soft and worthless, and gray shales predominate. The only fossils observed were a few worn and broken trunks of *Lepidodendra* and *Stigmaria*, with some indistinct fucoides. The upper limestone member of the Chester group, No. 27, is seen at a few points on Six-mile creek, and is well developed on Jordan from source to mouth. A good exposure occurs in the bed of that stream in the southwest quarter, section 17, township 11, range 5, carrying characteristic fossils, as *Bellerophon*, *Productus semireticulatus*, *P. cora*, *Spirifer striatus*, *S. lineatus*, *Pentremites Godoni*, and *P. obesus*, with stems of *Crinoidea*, *Pentremites*, and fronds of *Archimedes*. This stone has been burned, yielding a dark, cold lime, which will be most valuable for limeing land. Coal A, No. 24. is the only seam seen east of Eel river and north of Six-mile creek. A few outcrops were observed in the extreme southeastern corner of the district, and on the western bluff of Eel, north of Bowling Green. This seam is always irregular and inconstant, varying in thickness from naught to two feet, four inches, and at one point, southeast quarter of section 19, township 11, range 5, it is reported in a bore at three feet, eight inches. Time and money spent in development of this coal, as a rule, will result in disappointment and financial disaster.

The Conglomerate sandrock marking the rim and base of the coal measures is well developed. Two spurs or promontories are projected into this district, one at the north, another shorter and narrower at the south, bordering on three sides the deep, gulf-like basin of coals which extend six or eight miles east into Owen county. To the protecting influence of such promontories, and the quiet nature of the inclosed sea, we may probably attribute the origin of these block coals, which, according to Dr. Newberry, requires a long maceration and pretty complete pulpification of the vegetable matter composing the seam, before deposit. The Conglomerate furnishes the best of fire and weather-proof stone for foundations, piers and hammered masonry. The quick decomposition of the pyritous shale at its base, accounts for the formation of the rock houses here seen, and which is the horizon where silicate of alumina, "Indianite," may be sought and found in the neighboring counties. Coal B, No. 20 in section, is seen at only a few points and is generally thin and unimportant when there are so many thick seams near by.

A few miles within the basin, deep bores seem to indicate that the Conglomerate does not retain its typical exterior character, but passes to thin sandstone, siliceous shales and mudstones, and that the lower coals, A and B, are absent or barren. The coals I and J are grandly developed in nearly all the western part of this district. They occupy a horizon, generally barren in the coal measures, and seem to be interpolated between the regular coal seams as an addition, to illustrate the "fully crammed down, running over measure," with which nature has distinguished and blessed a part of the Indiana coal field, and especially Clay county. These seams usually occur at regular horizons, but, deposited in basins and troughs, their continuity is uncertain; many of the smaller basins being only a few hundred acres, while others are persistant for miles; hence the importance of fully "proving" lands before a shaft is put down. In the northern half of the district, I is distinctively and J usually block, burning dry, and well suited in a raw state for

smelting iron ore. Pure and remarkably free from sulphur phosphorus, etc., the pig metal is adapted to and is now largely used in the manufacture of Bessemer steel, the crowning triumph of our age. Some partings of splinty cannel exist in a few localities, and this feature seems to be in enlarged extent in the south part of the area. In such cases the coals are decidedly superior for rolling mill, locomotive and household use.

Coal K is just caught in the highest knolls near Centre Point and Ashboro, and is well developed at Clay City, Middlebury, and thence west; it is caking coal, contains some pyrites and burns with much flame to a red ash with clinkers.

Coal L was only found, in grand developement, at Middlebury. It underlies that village and shows a thickness of five to seven feet. It is semi-caking, or free burning, and is a good coal. Modified beds of the under-clay of L are found near Middlebury, which are probably as good as any, if not the best in the State. Some specimens of superior ware manufactured from this clay may be seen in the State Cabinet. It is suited for crocks, jars, tiles and terra-cotta work.

LOCAL DETAILS.

Bowling Green, the county seat, is situated upon an eminence which rises nearly 100 feet above Eel river, and commands a pleasant and extensive view along and across the valley of that stream. A slight bed of sandy loam covers the scarred, planished and worn bed of conglomerate which under-runs the hill, and affords interesting examples of glacial phenomena, already referred to. South of town, Mr. James Black, in a bore on southeast quarter, section 19, township 11, range 5, reports coal A of unusual thickness.

SECTION IN BLACK'S WELL.

	Ft.	In.
Hard sandrock	6	00
Soft sandstone and blue shale	12	00
Coal A	3	08
	21	08

A short distance south is a bluff exposure of the conglomerate sandrock, softer than usual—some beds have been quarried, but the stone is rather soft.

Good quarries are found north of town. At the Booth farm, on sections 12 and 13, the following exposure was seen:

SECTION AT BOOTH'S.

	Ft.	In.
Sandy clay	12	00
Sandstone and gray shale	8	00
Coal B, slaty—caking		06
Quartzose clay with stigmaria	3	06
Shaly sandstone	8	00
Massive conglomerate	12	00
Soft ferruginous conglomerate	18	00
Black shale in river	2	00
	64	00

On Albin Buell's farm, southwest quarter, section 17, township 11, range 5, a short distance above the mouth of the creek, is a good exposure of the strata, between coal A and the Chester beds:

SECTION ON JORDAN.

	Ft.		Ft.	In
Coal A and slate	2	to	0	04
Fire clay or blue shale			3	00
Diagonal bedded sandstone			8	00
Blue shale, with iron ore			11	00
Pyritous blue shale			8	00
Sandstone and shale			5	00
Ocherous iron ore			3	00
Kaskaskia limestone in bed of Jordan			16	00
			64	04

On John Cullin's farm, southeast quarter, section 18, township 11, range 5, a similar section is exposed; the roof slate of A, is largely composed of plant remains, including *Lepidodendra, Sigillaria, Cordaites* and *Calamites*.

A well on the top of the hill gives the following indications of glacial erosion and fill:

SECTION IN CULLIN'S WELL.

	Ft.	In.
Soil	1	06
Yellow clay,	12	00
Black peat		10
Hard pan, glacial drift, sticks and float coal	22	00
	36	04

Banks have been opened and worked for local use on each of these farms, and also by Henry Newport, on the northeast quarter, section 19, township 11, range 5. The Conglomerate rises from Jordan as it does from Six-mile valley, forming an anticlinal ridge between the streams, and which may be traced west by an upthrust of strata along the northern boundary of Sullivan county and across the Wabash river.

At Jno. Wood's bank, southwest quarter, section 21, township 11, range 5, coal A has been long worked for local use. The following outcrop is seen.

SECTION AT WOOD'S BANK.

	Ft.	In.
Slope and conglomerate	75	00
Massive conglomerate	4	06
Blue pyritous shale	4	06
Coal A	2	04
	86	04

This is a brilliant, cakeing coal, and bears a good reputation. A similar outcrop of A is reported on Rice's land, northeast quarter, section 29, township 11, range 5, two feet thick.

The surface about Poland is covered with a good drift and fluviatile soil. The brooks cut down to the level of coal A, here irregular and thin. No openings were in work.

The valley of Eel river is generally very wide, affording extensive fields which produce extra crops of corn. The "bottoms" north from Bowling Green to the northern boundary of the county are extensive, and owing to the generous admixture of sand from the circumjacent Conglomerate, of remarkable fertility.

On the west side of the river is the extensive and well appointed farm of Hon. M. B. Ringo. Large herds of cattle and hogs are fed and fattened from the corn lands, but an additional increase of equal or greater amount is derived from a source often neglected; the upland portion of his farm is seeded to grass, and devoted to grazing cows. The dairy, under the direction of his intelligent and accomplished lady, is a model for our State. The following section was taken at the northern boundary of the farm, section 20, township 12, range 5, near Carpenter's mills.

SECTION AT RINGO'S FARM.

	Ft.	In.
Surface clay and drift	20	00
Laminated and flaggy conglomerate, partly covered	27	00
Pyritous shale	8	00
Black sheety shale	1	04
Coal A ... 2 in. to	1	06
Stony fire-clay or blue shale	8	00
Chester sandstone and shale, to bed of river	22	00
	87	00

The farm comprises 700 acres of pasture, 250 of corn land, 60 for wheat and grass, with large reserves of timber, and was in excellent condition.

Going west from Eel river, the strata dip at the rate of from 60 to 100 feet per mile for a space of about two miles. The sandrock disappears below superior strata; coal B first appears as a mere parting or thin seam, but is soon succeeded by coals I and J.

Bennet Payne's bank, southeast quarter, section 14, township 12, range 6, has been worked more than 14 years, producing good block coal. On the same section, an association of miners under the name of the Limited Liability Coal Company, is working the same seam by a slope upon the land of Mr. Archie Love. The following section occurs:

SECTION ON ARCHIE LOVE'S FARM.

		Ft.	In.
Surface soil		2	00
Hardpan—glacial		9	00
Blue slate		9	00
Coal J?		3	10
Plastic clay		1	08
Black shale		1	08
Coal	1 ft. to	0	08
Gray shaly sandstone		10	00
		37	10

The coal of this vein is free from sulphur, easily mined in large blocks, and bears a good reputation, giving satisfaction to their customers at the Indianapolis Glass Works, the Terre Haute Nail Works, and Vigo blast furnace. The capacity of their fixtures is rated at 200 tons per day.

SECTION IN L. L. C. CO.'S MINE.

		Ft.	In.
Coal J?			
Semi-block—smiths coal		0	06
Block coal—good		2	08
Bone	1 in. to	0	02
Block coal			02
Soft clay—"bearing in"			02
		3	10

The roof coal is in great demand by blacksmiths. The soft underclay affords unusual facilities for "cutting under." The mine connects by a tramway with the Knightsville south branch switch of the T. H. & I. railroad.

Asherville is at the southern termination of the switch just mentioned. Adjoining the village is the shaft of D. N. Barnett, southwest quarter, section 15, township 12, range 6. It is 80 feet deep, and the fixtures, with a capacity for 150 tons a day, are first-class. The mine was not in work, but the product seen at the dump indicates a choice bed of block coal. The seam carries a thickness of three and a half to three feet nine inches.

Hoosierville is situated at the present southern terminus

of the Brazil south branch switch of the T. H. & I. railroad. The surrounding territory has been well tested by bores, which give much light on the mode of deposit of the block coals, which are found to be in basins, the coal rising from the central depressions to a hight of 20 feet at the eastern rim, and sometimes to an equal, but generally to one-third or to one-half less at the western rim, and thinning to a very narrow depth. A "thread" or parting of coal connects the different pools, however far apart. In one bank, Mr. Thompson, superintendent, tells me of a cone or hill 250 yards in diameter and 20 feet high, surrounded by coal 4 feet thick, which mounted on the sides of the cone, but thins to three feet at the top. Some of these basins are 200 to 300 yards in diameter, while others are measured by the mile. Adjoining the village are three shafts. Woodruff & Fletcher, northwest quarter, section 20, township 12, range 6, work coal J at a depth of 65 feet from the surface. The coal is from 3½ to 4½, averaging 4 feet thick, and gives the following:

SECTION AT WOODRUFF & FLETCHER'S MINE.

	Ft.	In.
Coal J.		
Upper block	2	04
Splinty cannel		06
Lower block	1	02
	4	00

The lower seam I, averaging 3½ feet, is not worked, the product of the upper, meeting a better demand. It is shipped to Chicago, where it is a favorite, the demand often exceeding the supply. The machinery, driven by steam, is well planned and in good order.

Woodruff and Cotton's shaft on John Borland's land, southeast quarter, southeast quarter, section 18, township 12, range 6, is fully equipped and works coal I.

SECTION IN WOODRUFF AND COTTON'S SHAFT.

	Ft.	In.
Clay and gravel	13	00
Glacial drift	5	00
Sandstone	3	00
Gray sandstone	24	00
Black shale	13	00
Coal J—average	4	00
Under-clay	4	00
Gray shale and sandstone	1	00
Coal I—average	2	06
Under-clay	3	00
	78	06

This land has been tested by nine bores, and they report a close agreement with the foregoing.

Johnny McCrea's shaft, on the same quarter section, is fifty-one feet deep, having both coals of workable thickness. He is now using J, but proposes soon to work the lower coal I.

The product of these shafts is favorably known as "Flint block coal." Their daily capacity is:

Woodruff & Fletcher	200 tons.
Woodruff & Cotton	200 tons.
McCrea	50 tons.
	450 tons.

The Oakhill slope, Ward & Perry proprietors, is situated on southwest quarter, section 19, township 12, range 6. They work the upper block coal J, which outcrops in an adjoining ravine. Their territory was proven by 24 bores, showing an average of 3 feet 4 inches in thickness. The following strata are seen in the slope and adjoining hill:

SECTION AT OAK HILL.

		Ft.	In.
Soil—clay		8	00
Coal K, caking		1	08
Fire clay		1	04
Sandstone and shale		28	00
Coal J, block	3 ft. to		
Upper block	3 00		
Splinty cannel	10		

Soft bearing in bed		03	4	01
Gray and blue shale			28	00
Coal I, block		2 ft. to	3	07
Blue siliceous shale			70	00
			144	08

This and other bores indicate a deep, muddy bottom under the block coals, certainly widening the space or blotting out coal B, and probably as well, the conglomerate and coal A, as before hinted. The Oak Hill machinery and fixtures are well devised, in first class condition, and have a capacity of two hundred tons per day; 25 men were a work, producing 60 tons a day.

Going south from Hoosiersville, nearly all the lands have been tested, with, generally, favorable results, and show a long, wide lake of coal, having a general thickness of about three feet, varying from two to four feet. From want of transportation, no shafts have been sunk, and these are necessary for investigation.

Centre Point is a thriving village, that has contested for the county seat. It is the centre of a high, gently rolling plateau of well timbered lands and productive fields. Steadman's bank, southwest quarter, section 3, township 11, range 6, has been worked by slope for several years, supplying the village, mill, and localities east and south, especially Bowling Green.

SECTION AT STEDMAN SLOPE.

			Ft.	In.
Clay soil			12	00
Coal K				04
Fire clay			1	00
Shaly sandstone			18	00
Coal J.				
Best cakeing coal	0	06		
Block coal	2	06		
Splinty cannel	0	07	3	07
Shaly clay			4	00
			38	11

Immediately north of the village, Kennedy's shaft, southeast quarter, section 4, township 11, range 6, was begun at the level of coal J and put down to I.

SECTION AT KENNEDY'S SHAFT.

			Ft.	In.
Coal J in outcrop			3	01
Shaly clay			3	00
Shaly sandstone			19	00
Coal I, block.				
Roof coal, caking	0	08		
Block coal, choice	2	06		
Splinty cannel	0	03		
Cubic Albertite	0	03		
Soft, bearing in coal	0	03	3	11
Clay in sump			3	00
			32	00

Seam J furnishes a good grate and steam fuel. I is a strong block coal, free from sulphur, and burns to a white ash without clinker.

Northeast of town, coal was formerly stripped on the lands of Sharp, Carter, Hicks, and Nagle, sections 27, 28, 34 and 36. The openings were not in work, but the outcrops confirmed the report of good workable seams at these points. The surrounding territory has been carefully tested. The underlying seams are generally workable, but a few barren spots intervene.

William Butt has mined by stripping for several years, on east half, southeast quarter, section 32, township 12, range 6. Seam J here furnishes excellent block, free from sulphur, containing a thin layer of brilliant, resinous coal. The tract was tested for Ormsby & Co. by 14 bores, all of which, except two, developed seams J and I of workable thickness.

	Ft.	In.
For the 12 bores, the average thickness of J	3	03
Average space between	18	00
Average thickness of I	3	05

The northeast quarter, section 4, township 11, range 6,

belonging to the same owner, was tested by three bores, of which a copy was furnished and is here tabulated:

No.	Space. Ft.	In.	Coal J. Ft.	In.	Space. Ft.	In.	Coal I. Ft.	In.
1.	15	00	2	08	14	04	1	06
2.	12	00	3	00	22	00	1	02
3.	40	00	1	11	13	06	1	07

On L. C. & R. L. Kennedy's land, southwest quarter, section 34, township 12, range 6, a deep bore shows one of the irregularities of the field.

SECTION IN KENNEDY'S BORE.

	Ft.	In.
Soil and glacial drift	12	00
Coal K, soft	2	00
Potter's clay	4	00
White sandstone	3	00
Gray shale	8	00
Shale and sandstone	9	00
Blue shale	10	00
Coal J		07
Shale and sandstone	12	00
Shale and sandstone	16	00
Blue shale		06
Coal I	1	00
Shale and slate	22	00
	100	00

A similar section, kindly furnished by Col. Blood, shows the limestone occurring over coal K, in a bore on section 4, township 12, range 6.

SECTION AT COL. BLOOD'S BORE.

	Ft.	In.
Surface	22	00
Blue shale	5	00
Hard blue limestone	2	00
Place of K		
Shale and sandstone	46	00
Soft coal J	1	08
Clay and siliceous shale	11	04
Coal I	2	00
Clay and shale	10	00
Coal B?	1	00
Gray sandy shale	14	06
	115	00

East of town, Dr. Gilfillan's bore pierces the conglomerate sandrock.

SECTION AT GILFILLAN'S BORE.

	Ft.	In.
Clay and soil	12	00
Shaly sandstone	20	00
Blue shale, place of coal I	15	00
Shaly sandstone	20	00
Gray shale	10	00
Coal B	2	08
Plastic clay	2	00
Hard rock—conglomerate	25	00
Black gray shale	10	00
Coal A		05
Plastic Clay	2	00
	145	01

On A. Gibbon's farm, southeast quarter, section 5, township 11, range 6, coal K has long been worked by stripping; it cakes and is in demand for smiths use, being so perfectly free from sulphur that it does not decompose on exposure to the air. Annexed is the average of 12 test bores, as reported by the proprietors:

SECTION AT GIBBON'S, IN OUT-CROP AND BORE.

	Ft.	In.
Surface clay	20	00
Sandstone	2	00
Bituminous limestone	1	08
Black slate, pyrite balls		06
Coal K—choice caking	1	04
Fire-clay and shale	6	00
Hard sandstone	8	00
Blue shale	11	00
Coal J	3	08
Clay and shale	7	00
Shaly sandstone	8	00
Gray shale	10	00
Coal I	3	09
Laminated fire-clay	2	00
	84	11

Southwest of Centre Point many test bores have been made, and the result reported, which shows that coals J and I are present and generally have a good, workable, thickness of two feet six inches, to two feet eight inches. In consequence of this showing, a shaft was sunk and fixtures made ready for work by J. W. Morrison on J. W. Moss's land, northeast quarter, section 8, township 11, range 6:

SECTION IN MORRISON–MOSS SHAFT.

	Ft.	In.
Surface clay 1 to	10	00
Coal J, block	8	06
Clay and siliceous shale	20	00
Coal I, block	3	09
	47	03

The shaft and fixtures were completed, ready for work, when the financial panic of 1873 compelled a suspension of so many enterprises. The same cause prevented the completion of a switch that is graded to near this place.

SECTION OF COAL IN MOSS'S SHAFT.

	Ft.	In.
Coal I.		
Semi-block		10
Choice block	2	00
Bone		02
Block coal		11
	3	11

At Ashboro there are no facilities for transportation. Stripped banks, alone, are worked for the local demand. Openings, not in active work, are reported on the following tracts:

McKeen and Minshall, southeast quarter, section 17, township 11, range 6, coal J.

Geo. Moss, northwest quarter, section 16, township 11, range 6, coal J.

Phil. Fencel, northeast quarter, section 16, township 11, range 6, coal J.

J. Ferguson, northwest quarter, section 21, township 11, range 6, coal K.

On these lands, seam J has a thickness ranging from two to nearly four feet, averaging three feet six inches. Wherever tested, the entire area is underlaid by seam I, with an average thickness of over three feet.

SECTION IN GEO. MOSS'S BORE.

(East of Ashboro, southwest quarter northwest quarter, section 16, township 11, range 6.)

	Ft.	In.
Surface soil	6	00
Blue shale	10	00
Coal J, block	3	00
Shaly clay and sandstone	9	00
Soapstone and shale	15	06
Dark shale	12	00
Coal I, block	3	06
Shaly clay	1	00
	59	06

James Ferguson's medicinal chalybeate spring was noticed in the first annual report, 1869. It retains its healing properties. The survey is indebted to Mr. Ferguson for many important items of scientific interest, especially for the discovery and careful study of the glacial markings in the vicinity of Bowling Green. Outcrops within a short distance west on Ferguson and Grimes' farms are added.

SECTION ON FERGUSON—GRIMES' FARMS.

	Ft.	In.
Clay soil	12	00
Red ferruginous sandrock	16	00
Pyritous shale	4	00
Bituminous limestone	4	00
Black slate	1 to 4	06
Coal K, caking	1	08
Fire clay	4	00
Gray and blue shale in bore	28	00
Coal J	1 to 3	06
	77	08

Passing from Ashboro to Belle Air, the Conglomerate is found in the bluffs or bed of Eel river. At George Rhodes' section 34, township 11, range 6, it is well developed in quarry beds, where the upper surface is shaved off by the great ice flow of the Glacial Age, and to which phenomenon the deep, wide, valley of Six-mile creek owes its origin. Along the latter stream, and west of the Rhodes farm, coal A, in a thin seam, is seen at or near low water. Going south a deep alluvium covers the rocks. Coal is only worked for household use during the winter, and the seams were not visible. The specimens seen, indicated coal J as the surface seam, at Cole and Goshorn's, section 10, Kilmer's, section 16, and Kearn's, section 17, township 10, range 6.

Peter Barrick's strip bank was not fully determined. The coal is somewhat blocky, but the companion strata resemble those of B.

SECTION AT BARRICK'S SEAM.

	Ft.	In.
Block coal.......2 to	1	02
Bright cubic coal	1	00
Splinty cannel	0	08
	2	10

The overlying shales are filled with small ironstone nodules which enclose leaves, stems and fruits of Carboniferous plants, viz: *Neuropteris rarinervis*, *N. hirsuta*, *Odontopteris*, *Hymenophyllites*, *Cordaites borassifolia*, *Sphenophyllum Schlotheimi*, *Asterophyllites equisetiformis*, terminal spikes and leaves of *Lepidodendron*, striated stems of ferns and the fruits *Cardiocarpum* and *Trigonocarpum*.

Coal City is situated on the southwest quarter, section 11, township 9, range 6, adjoining the line between Clay and Owen counties. Twentysix bores are given, tabulated in report on Owen county. They were put down by the Bessemer Company, under direction of Prof. Wilbur; their shaft is incomplete. The Coal City shaft, in the western suburb, is by the side of the graded bed of the Cincinnati

and Terre Haute railroad, and ready for work. The following section was obtained from those engaged in the enterprise.

SECTION IN COAL CITY SHAFT.

	Ft.	In.
Surface clay	12	00
Glacial hardpan	20	00
Soft, yellow sandstone	30	00
Gray shale and thin coal	10	00
Gray pyritous shale	10	00
Gray pyritous shale, with plant remains	4	00
Blue and dark shale	10	00
Coal I ... 2 ft. 11 in. to	3	00
(Bore in same.)		
Fire clay	1	06
Gray siliceous shale	30	09
White sandstone and shale	18	00
Massive Conglomerate	43	06
	192	11

The shaft was put down under the direction of Mr. Jno. C. Northall, a mining engineer of skill and experience, and to whom I am indebted for the information that the coal at the bottom of the shaft was very pure block, three feet eight inches thick. This shaft and the table of bores on sections 11, 14 and 24, township 9, range 6, a short distance southeast of the village and given in the report on Owen county, affords a pretty full view of the coal in this vicinity, to which may be added the out-crop of coal B? at Wagstaff's southeast quarter, section 15 township 9, range 6.

Less than a mile north of Coal City, on land belonging to the heirs of A. Harstein, is an outcrop of bituminous limestone, containing *Spirifer cameratus*, *S. lineatus*, *Athyris subtilita*, *Productus cora*, *P. punctatus*, *P. longispinus*, *Chonetes mesoloba*, and *Bryozoans*. The fossils, limestone and slaty coal indicate the horizon of seam K. Below is another seam having the position, though not the usual qualities of I. The following shows the connected outcrop:

SECTION AT HARSTEIN'S.

			Ft.	In.
Soil			10	00
Bituminous limestone			3	00
Place of coal K				
Shaly sandstone			22	00
Coal I?				
Laminated coal	1	00		
Splinty cannel		10		
Bright resinous		08	2	06
Fire clay and shale			2	00
			39	06

Three bores were put down, for the Pittsburg company, on the east half of the northeast quarter of section 3, township 6, adjoining, with the following results:

SECTION IN CLOW'S BORES.

VAN HORN FARM.

Bore No. 1.

	Ft.	In.
Surface, soil, etc	3	00
Gray shale	23	00
Block coal	3	09
	29	09

Bore No. 2.

Surface soil, etc	15	00
Soap stone	5	09
Blue shale	15	06
Block coal J ?	2	07
Shaly coal	3	04
Shaly sandstone	17	00
	59	09

Bore No. 3.

Surface, soil, etc	12	00
Hardpan	16	00
Red clay	5	00
Dark slaty shale	3	06
Coal J?	1	06
Shaly sandstone	7	00
Block coal I	4	02
Shaly sandstone	1	06
	50	08

The first bore was at the centre of the north half, the third at the centre of the south half, and the second in the middle of the above tract of land.

Going west from the tract just mentioned, the surface is deeply covered with fluviatile loams. A single outcrop was noticed on the bank of White Oak creek, without opportunity of seeing and determining the coal. John Storm works a thin irregular seam, by stripping, on southeast quarter, section 6, township 9, range 6. It is a choice resinous caking coal, very pure and free from sulphur, and burns with much flame to a white ash, without slag or cinder. It is an excellent blacksmith fuel and would probably answer for gas making. The strata here rise to the south and east, toward the promontory of conglomerate, seen projected into the basin at the southeast corner of this county, and dip rapidly to the west and north toward the coal measure trough which is so boldly extended in the direction of Patricksburg, Owen county.

SECTION AT STORM'S BANK.

	Ft.	In.
Soil	8	00
White and yellow micaceous shaly sandstone	5	00
Pyritous gray siliceous shale	2	10
Coal J ? 2 ft. to	4	06
Fire clay	3	00
	23	04

Middlebury is located upon a sandy knoll which overlooks and is surrounded on all sides by a vast alluvial plain. The town, by actual level, is 126 above the feeder dam on Eel river, 195 feet above the bottom of the canal, and 238 feet above low water in the Wabash river at Terre Haute.

The limited elevated area on which the town is situated is an outlier of the middle coal measures which once covered a large surrounding region, reaching west across the valley of Eel river, north ten miles to Centre Point, and east four miles to the county line, which, save this knoll, was almost

wholly eroded in the past by ice and river action. Coal L is found near the surface in a monster seam 8 to 11 feet thick. Coal K. is worked in the ravines and low lands, and is 2 to 4 feet thick. The following general section gives a connected view of the coals and the surface deposits:

SECTION AT MIDDLEBURY.

(Connected.)

			Ft.	In.
Fluviatile sand			15	00
Lacustral sand—Loess			10	00
Lacustral silt—quicksand			12	00
Coal L——6 to 11 feet thick.				
Laminated coal	0	06		
Choice thick caking band	1	02		
Soft clay parting		04		
Cubic caking 3 to	4	00		
Laminated coal	1	00	8	00
White fire clay			3	06
Cherty, argillaceous sandstone, passing to calcareous argillite			8	06
Blue or gray soapstone			3	00
Blue calcareous argillite, passing to bitumiuous limestone 7 to			3	00
Yellow soapstone or shale 7 to			2	00
Black slate with prints of shells and plants, and fish remains, partly impure cannel coal			4.	00
Coal K caking 2 to			3	06
Fire clay			4	00
Shale, sandstone and slate			42	00
Block coal I?			3	02
			121	08

Coal K, adjacent to town, is worked by W. R. Kress, northwest quarter, section 6, township 9, range 6, and is one and a half to two feet thick; by Ambrose Phipps, southwest quarter, southwest quarter, section 30, township 10, range 6, four feet thick; and is pierced by a bore made by J. R. Langford at his steam mill, where it is thin. The coal is a strong, fat, caking coal, but contains some sulphur and burns with considerable yellow flame to a red ash, with clinkers and cinder. The overlying slate contains boulders

and large concretionary beds of pyritous ironstone, which, with the superimposed argillaceous limestone, is an almost constant characteristic of this seam. This slate burns readily with much flame, leaving a large quantity of white clayey ash, and has been termed cannel coal. At A. Phipps' bank this shale contains some interesting fossils as *Nautilus decoratus*, *Aviculopecten rectilateraria*, *Orthoceras Rushensis*, *Petrodus occidentalis*, teeth and spines, and coprolites and bones of fishes. The limestone over the slaty roof of K is generally barren, but on the land of M. Gray, section 3, township 9, range 6, contains *Productus punctatus*, *P. cora*, *P. costatus*, *P. longispinus*, *Spirifer cameratus*, *S*, (*sp.?*) *Hemipronites crassus*, *Chonetes mesoloba*, *C. Smithi*, *Leda bellastriata*, *Phillipsia Sangamonensis?*, with coarse Bryozoans and crinoid joints. The space here, between coals K and L, ranges from 18 to 24 feet, and the average of five measurements is 21 feet. Seam L is worked in the outskirts of Middlebury by Elias Cooprider, northwest quarter, section 31, township 17, range 6, by stripping, and is eight feet six inches to eleven feet thick; by R. Horton and Jacob Harris, on the southwest quarter of same section by adit, with a thickness of six to seven feet; and by John Cooprider, on the northeast quarter of section 31, where it is seven to eight feet thick. Coal L here presents the usual characteristics of the same, so constant throughout the State. It is a laminated, semi-caking or free burning coal, which, in combustion, produces a whitish flame and white or gray ash, with little or no clinker. It is an excellent coal, well suited for stationary boiler, locomotive, rolling mill, stove and grate use, but is not a good smith fuel. The upper and lower divisions, when sulphurous, should be rejected.

One mile northeast of Middlebury on the farm of Mr. Everhardt, is an excellent, if not one of the best deposits of potters clay in the State. It probably results from the under clay of coal L, naturally washed and modified by fluviatile or lacustral agencies and here redeposited. The bed is several feet thick and contains bands two or three

feet thick, of nearly pure white color, suitable for use without washing or other preparation. It is worked and burned by Lawrence Schmere, producing crocks, jars, mugs, pitchers, flues, water pipes and drain tiles, of superior excellence and artistic design. The ware is generally of a creamy white color; but by the addition of other materials, gray and yellow ware is made. The quantity of clay seems to be unlimited, and the quality is such as to earnestly invite the attention of potters.

Clay City, (Markland post office), is situated at the present terminus of the Cincinnati and Terre Haute railroad, but arrangements are very nearly completed for the extension of the road to the neighboring beds of coal and rich minerals. The embryo city is surrounded by broad alluvial plains which were originally clothed with valuable forests of oak, poplar, hickory, etc.; part of these trees have been manufactured into lumber, staves, etc., and shipped, but extensive forests of choice timber still remain. Reduced to cultivation, this land produces good crops of corn, wheat and oats. While the surface is thus rich and productive, a greater treasure lies buried fifty to eighty feet below, consisting of the fine coals, worked by the Markland Coal Co., and pierced by nearly 100 bores.

Markland shaft is located on the farm of Henry Coopri-der, and is connected by switch with the Cincinnati and Terre Haute railroad. The shaft is eighty-two feet from the surface to the coal, making a total depth of eighty-five feet six inches. It is sixteen by eight feet wide, separated into three divisions, two for hoisting coal and the central one for the pump and return air course. The inside workings are fully opened and ready to do a large business. The engine and boiler house is detached and totally disconnected from the shaft buildings and dump, so that in case of fire, the latter and the lives of the miners may not be endangered. The fixtures put up under the direction of Mr. John C. Northall, to whose courtesy thanks are due for information, are first-class in every respect, and have a capacity for delivering 100 tons per day. The surrounding

tract has been fully "proved" by the bores, and Mr. N. report that in thickness of coal and regularity of strata, it is the most uniform that he has ever drilled in this region; varying but little from the accompanying section in shaft.

SECTION IN MARKLAND SHAFT.

	Ft.	In.
Surface soil	5	00
Gray sandrock	5	00
Soft coal L?	2	00
Hard fire clay	6	06
Black slate	3	06
Place of coal K?	0	00
Hard slate	9	06
Fire clay	7	06
Black shale	11	00
Gray shale	14	06
White sandrock	8	06
Black shale	14	00
Block coal I?	3	06
	85	06

On a hill on the same tract of land a hole w drilled with the following result:

SECTION IN BORE NEAR MARKLAND.

	Ft.	In.
Surface soil	4	00
Soapstone	15	00
Blue shale	3	06
Impure cannel slate	5	00
Bituminous coal K ?	4	06
Soapstone	5	10
Silicious shale	15	00
Blue shale	7	00
Shale and sandstone	4	00
Blue shale	8	00
Coal—block	3	02
Fire clay	1	06
	76	06

The following sub-section shows the mode of occurrence of the coal in the mine by sub-divisions:

SECTION IN MARKLAND MINE.

	Ft.	In.
Coal I?		
Choice block coal	1	08
Glistening "Albertite"		04
Splinty cannel		04
Semi-block	1	02
	3	06

This seam is typically a block coal, but has partings and divisions, which contain much volatile matter; it is, therefore, a superior fuel for locomotive and other steam engines, rolling mills, and for household use. Just above the worked coal a thick bed of gray and blue shale contains immense numbers of the stems of ferns, with many finely striated leaves of *Cordaites borassifolia*, *C. angustifolia*. *Neuropteris hirsuta*, *N. rarinervis*, *Pecopteris*, 3 species, *Sphenophyllum*, *Schlotheimi*, *Asterophyllites equiseti-formis*, *Adontopteris*, sp? and a *Cardiocarpum*.

Niblock, Zimmerman & Alexander, of Brazil, at a heavy expense, have fully proved an extensive area about two miles east of Clay City, comprising nearly 1,000 acres, and have liberally furnished their records of the following bores:

SECTION IN BORES ON CROFT'S FARM.

South half, of northeast quarter, section 33, township 10 range 6.

First Bore.

	Ft.	In.
Surface clay	15	00
Hardpan	8	00
Blue shale	7	09
Coal		03
Fire clay	3	03
Blue shale	25	00
Blue slate	2	06
Coal	2	10
Fire clay	6	06
Blue shale	8	03
Blue slate	1	00
Coal	1	00
Fire clay (not passed)		
	81	05

Croft's Farm—Second Bore.

	Ft.	In.
Surface clay	14	06
Hard pan	9	00
Yellow clay	9	03
Yellow shale	9	00
Blue shale	3	00
Blue slate	1	03
Coal	1	10
Fire clay	2	06
Gray shale	13	03
Coal J	2	04
Fire clay, shaly	8	00
Blue and black shale	10	09
Coal I	3	06
	88	02

Croft's Farm—Third Bore.

	Ft.	In.
Surface clay	14	00
Hard pan and clay	41	00
Blue slaty shale	9	02
Coal J	2	04
Fire clay	4	06
Blue and gray shale	13	06
Coal I	3	03
	87	09

Croft's Farm—Fourth Bore.

	Ft.	In.
Surface clay and drift	29	06
Gray shale	9	00
Coal	0	08
Siliceous clay	4	06
Coal		02
Gray shaly fire clay	25	05
Black slate		06
Coal J	3	03
Shaly fire clay	6	06
Blue and black shale	16	09
Coal I	4	00
	100	03

Croft's Farm—Fifth Bore.

Clay and drift	34	10
Coal		07
Siliceous fire clay	4	08

Gray sandstone	18	09
Blue slate	1	00
Coal J	3	04
Shaly clay and sandstone	7	04
Blue and black shale	19	06
Coal I	3	06
	96	00

The deep bore on Shidler's farm, north half of northwest quarter, section 33, township 10, range 6, after finding the horizon of the coals barren, probably passed through the Conglomerate, thinned to less than thirty feet of white sandstone and pierced the dark aluminous shales at the top of the sub-carboniferous:

SECTION IN SHIDLER'S BORE.

	Ft.	In.
Clay, hard pan, sand, etc	55	00
Dark blue shale	39	06
Gray shale and fire clay,	10	02
Gray sandstone	5	07
Hard white sandrock conglomerate?	21	00
Shaly sandstone	7	02
Limestone		08
Dark aluminous shale	11	06
Dark slate		06
Slaty coal		07
Dark shales with iron balls	3	00
Gray, blue and black shales	35	09
Shaly clay	2	04
	194	04

SECTION IN BORES ON THE JETT FARM.

The property of Niblock, Zimmerman & Co, north half of southeast quarter, section 33, township 10, range 6.

First bore in an old river bed.

	Ft.	In.
Surface clay	16	00
Hard pan—silt?	31	00
Blue clay	5	00
Harp pan	16	00
Quicksand, not passed	2	00
	70	00

Jett Farm—Second Bore.

Surface clay and hardpan	22	00
Rotten coal L.?	2	00
Fire clay and sandstone	4	02
Black slate	4	08
Coal K		06
Fire clay and white sandstone	16	08
Blue shale	11	10
Coal J	3	02
Shaley fire clay	7	06
Blue and black shale	18	01
Coal I	3	01
	93	08

Jett Farm—Third Bore.

Surface clay and hardpan	44	06
Sandstone	9	03
Blue shale	25	09
Coal J	3	06
Stony fire clay	6	06
Blue and black shale	10	06
Coal I	3	00
Fire clay	1	00
	104	00

Jett Farm—Fourth Bore.

(In an ancient river bed.)

Surface clay	14	00
Hardpan—silt	18	00
Quicksand	11	06
Yellow clay and gravel	9	03
White clay	2	02
Float sandrock	1	06
Quicksand	8	04
Hardpan—silt	4	07
Clay and sand, not passed	2	07
	72	00

Jett Farm—Fifth Bore.

Surface clay	14	06
Hardpan	14	00
Yellow clay	11	06
Quicksand	3	06
Hardpan	6	00
Soft clay and sand	32	06

Gray shale	4	00
Coal		06
Fire clay		03
	90	00

Jett Farm—Sixth Bore.

Surface clay	7	00
Hardpan	51	00
White sandstone	5	00
Blue and black shale	63	02
Dark siliceous shale	15	00
Stony fire clay	5	09
	147	00

Jett Farm—Seventh Bore.

Surface clay	18	06
Hardpan	33	09
Sandstone and siliceous shale	7	09
Coal J	3	10
Fire clay	4	06
Dark shale	14	04
Coal I	2	09
	85	05

BORES ON THE MOODY FARM.

South half, northwest quarter, section 33, township 10, range 6.

Moody Farm—First Bore.

	Ft.	In.
Surface clay	5	00
Hardpan	3	00
Sand	13	00
Hardpan	22	06
Gray shale	9	00
Coal J	1	09
Fire clay	4	03
Sandstone and gray shale	17	06
Coal I	2	10
Black slate and fire clay		08
	79	06

Moody Farm—Second Bore.

	Ft.	In.
Surface clay	13	00
Hardpan	3	00
Quicksand	1	06
Hardpan	3	06
Sand—quick	4	06
Hardpan	14	04
White clay	2	08
White sandstone and shale	10	06
Rotten coal—place of J	1	06
Fire clay	5	11
Gray sandstone	6	01
Rotten coal—in place of I	0	09
Fire clay	1	06
Gray sandstone and shale	10	09
Dark-blue shale—in place of B	42	03
Gray shale	3	06
Dark-blue shale	2	00
Hard white sandstone	1	02
	128	05

BORES ON GARLITT'S FARM.

Southwest quarter, southwest quarter, section 33, township 10, range 6.

Garlitt's farm—First Bore.

	Ft.	In.
Surface clay	15	06
Gray shale	15	08
Blue shale	2	03
Coal J?	2	01
Fire clay	3	01
Sandstone and gray shale	11	06
Blue shale	3	06
Coal I?	3	01
Fire clay and shaly sandstone	11	05
Blue shale, place of B?	14	01
Fire-clay, sandstone and shale	3	10
	86	00

Garlitt's Farm—Second Bore.

Surface clay	14	00
Hardpan	23	08
Blue shale	4	09
Coal J?	1	00
Fire-clay	10	04
Blue shale	5	06
Hard gray shale	12	06
Gray limestone	1	02
Hard gray sandstone	15	04
	88	03

BORES ON BUZZARD'S FARM.

Southeast quarter, southwest quarter, section 33, township 10, range 6.

Buzzard's Farm First Bore.

	Ft.	In.
Surface clay	24	00
Drift gravel	3	00
Hardpan	5	10
Gray shale	8	02
Fire-clay	11	06
Gray shale,	8	06
Blue shale, with plates of sandstone	6	09
Coal I ?	2	06
Fire-clay		06
	70	09

Buzzard's Farm, Second Bore.

	Ft.	In.
Surface clay	5	06
Hardpan	50	06
Quicksand	9	06
Hardpan	8	00
Blue clay	7	00
Gravel—drift	2	06
Sandstone	5	00
	88	00

The foregoing bores, eighteen in number, are given in detail that they may be preserved for the benefit of Clay county in general. They are all on section 33, township 10, range No. 6, and give an exhaustive exhibit of the

coals, rocks, etc., on that section of land; and at the same time partially maps out an ancient river channel, now completely filled up, (for the variations in the present surface will not exceed twenty feet,) which flowed from the northwest through the level plain east of Middlebury and thence towards Worthington. It is obvious that at such stations the coals and rocks have been removed by erosion. This old channel has been so often pierced on this tract, and at many other places, that its existence, with well defined outlines, cannot be doubted; and it is to be regretted that a complete record of all such wells was not available, for by this means the limits of this destructive excavation could have been mapped, and thereby much loss and disappointment to subsequent explorers prevented.

Saline is a new village which has come into existence since the commencement of the Cincinnati & Terre Haute railroad. It is surrounded by a good agricultural region, including large areas of river bottoms, which produce great crops of corn. The adjacent forests contain a quantity of valuable timber, which is being rapidly prepared for market, as railroad ties, lumber and staves. Post oaks prevail on the Loess loams, and are rated as superior for ties, because of their solidity and endurance.

The "Knickerbocker Coal Company" has control of the west half, of the southwest quarter, of section 30, township 11, range 6, west, adjoining and immediately southeast of the village. This tract of land is nearly level; the inequalities will not exceed eight feet. By levels and bores it is found that the coal dips from the northeast corner of the 80 acres to the shaft (bore No. 10), nine feet, or at the rate of 27 feet per mile. Here the dip is suddenly reversed, and the coal rises 11 feet at the southwest corner of the land. The worked seam is persistent and uniform, and remarkably free from interruptions. In driving the entries 1,200 yards, only two small horse-backs were found, and these less than a yard in width.

The company put down a series of 11 bores, which sufficiently proved the coals on their land, and give a typical exhibit of the underground structure of this vicinity.

It will be observed that an ancient river bed, now completely filled up and level, crossed this territory in an excavation from 22 to 47 feet 6 inches deep, and had, at two stations, completely removed the sandstones and shales that ordinarily cover the coal. The shaft was put down at bore No. 10. The record of all the tests is condensed in the following table. The position of the bores is indicated by corresponding numbers on the detached map of said west half of the southwest quarter, of section 30, township 10, range 6, of Clay county, on the margin of the map of Owen county, for this Seventh Annual Report of the State Geologist.

BORES BY KNICKERBOCKER COAL CO.

Section 30, Saline, Clay county, Indiana.

MATERIAL.	NUMBER OF BORE.										
	1	2	3	4	5	6	7	8	9	10	11
Surface clay	16.00	17.00	15.00	18.02	12.00	20.00	16.00	18.00	17.00	14.00	10.00
Quick sand	6.06	......	8.00	......	21.02	27.06	31.06	9.00	......	2.00	......
Sandstone, gray shale, etc	22.06	17.00	15.06	18.10	14.04	......	......	......	14.06	26.06	8.00
Dark hard shale	5.02	8.08	9.00	27.08	9.02	......	......	17.09	13,00	7.00	26.06
Block coal I?	3.00	3.02	3.02	3.00	3.02	2.09	3.00	3.00	3.02	3.00	3.04
Fire clay, shale and S. S.	44.10	.07	.04	.04	.02	.08	......	......	......	.. ..	......
Totals	98.00	46.00	51.00	68.00	60.00	50.06	50.06	47.09	47.08	50.06	47.10

The Knickerbocker Coal Company have equipped their shaft with a steam engine of 45 horse power and complete modern fixtures; the capacity of the machinery is for the

delivery of 250 tons a day, but lacking demand, the duty is from fifty to eighty tons a day. The coal is lamellar, with lustrous divisions separated by partings of vegetable charcoal, burns to a white ash, and is a choice coal for locomotive, rolling mill and household use. Wherever put upon the market, it has been adopted as a substitute for wood, by those who desire a bright, cheery fire, like that of old fashioned hickory wood, as it is admirably suited for burning in open grates.

Bores put down on the Jamison farm, adjoining Saline at the north and west, develop the existence of a greater number of seams:

SECTION IN JAMISON'S BORE.

Section 25, township 11, range 7.

Jamison's First Bore.

	Ft.	In.
Surface	14	00
Hardpan	8	00
Clay and gravel	11	00
Soft sandy shale	15	00
Blue shale	12	00
Coal J—block	2	10
Fire clay	1	06
Siliceous shale	13	00
Coal I		10
Fire clay	2	00
Siliceous shale	13	00
Coal B—caking	2	05
Blue sandrock	2	06
	98	01

Jamison's Second Bore.

	Ft.	In.
Surface clay	15	00
Sand and gravel	25	00
Blue clay	13	00
Shale	3	00
Coal J—block	2	11
Fire clay	2	00

Siliceous shale	11	07
Splinty coal I		08
Fire clay	1	06
Gray shale	10	06
Caking coal B	1	06
Sandrock		06
	87	00

The mineral wealth, and the superiority of the vast beds of block coal in Clay county, has been fully set forth in Prof. Cox's former reports. Any further statement would be a mere repetition, and unnecessary. He has shown that it may be used in a raw state for the smelting of iron ores in the blast furnace, and that the resulting pig metal is well adapted for conversion into steel. The latter fact is of signal importance. The world has passed through the educational ages of stone, bronze, iron, gold and silver, and has reached the highest plane of civilization—the age of steel. The higher man demands implements, tools, engines, ships, bridges, rails, and carriages of the most perfect form and materials; and, as if in answer to the call of humanity, a coal is found here in vast beds, that is naturally adapted to the preparation of the fine grades of pig metal, such as are required for the manufacture of steel by the pneumatic process. That distinguished mining economist and faithful laborer in science, Col. J. W. Foster, late President of the American Association for the Advancement of Science, after a minute, patient and thorough examination of this field, in a series of letters to the New York Tribune, bears unqualified testimony to the inestimable value of this coal, and with the prophetic spirit that foresaw the wonderful future of the Lake Superior mineral region, predicts for this part of Indiana a prosperity commensurate with its advantage of being the centre of the most extensive block coal field now known.

THANKS.

Acknowledgements are due to all the citizens of the county for information and kindness. My heartiest thank

for hospitality and special favors are returned to the following named persons: Niblock, Zimmerman & Alexander, Col. H. B. Blood, Col. H. L. Ashley, T. G. Clark, George Grimes, Messrs. Kennedy, J. T. Carithers, Dr. Gilfillan, Hon. and Mrs. M. B. Ringo, Messrs. Cornell & Love, Alex. Brighton, J. H. Dillon, Black & Thompson, Maj. W. W. Carter, James Ferguson, Henry Grim, G. W. Wiltse, John C. Northall, M. E., Mr. Quackenbush, H. Jamison, and the Presidents of the Terre Haute and Indianapolis, of the Evansville, Terre Haute and Chicago, and the Evansville and Crawfordsville railroads.

GEOLOGICAL RECONNOISSANCE

OF THE

COAL MEASURE ROCKS OF PUTNAM COUNTY.

BY JOHN COLLETT.

Examinations in Putnam county were limited by instructions to the coal measure rocks lying in the extreme western part; but no mention will be made of the underlying subcarboniferous beds which form the general surface rocks, and are exposed in a majority of the valleys and ravines in the district under consideration. The area in which these rocks occur in Putnam county is bounded on the west by the west line, on the south by the south line of the county, as far east as the western bluff of Doe creek, thence northeast along said bluff to Jno. B. Sackett's sandstone quarry, two miles west of Cloverdale, thence nearly north and northwest by Cemetery Hill, at Greencastle, and Morton, to the northwest corner of the county. The foregoing boundary includes the most extreme eastern outliers of the Conglomerate sandstone and coal A. Throughout this area, the streams, brooks and branches have cut down to the underlying limestone; and over one-fifth of it have wholly eroded and moved the coal measure rocks, as in the wide valleys of Big and Little Raccoon, Walnut fork, Deer creek, Eel river and their tributaries. The surface is generally rolling or hilly, the soil, although not of the best,

produces corn, wheat, oats, and the grasses, and some extensive belts of oak, poplar and beech timber, were noticed.

CONNECTED SECTION OF THE COAL MEASURE ROCKS.

		Ft.		Ft.	In.
1.	Soil and drift	90	to	20	00
2.	Groy shale with iron nodules			11	00
3.	Coal B (on outcrop)	3	to	1	00
4.	Fire clay			2	00
5.	Gray shale and sandstone	20	to	10	00
6.	Conglomerate	10	to	80	00
7.	Aluminous shale	10	to	4	00
8.	Coal A	0	to	2	00
9.	Fire clay	5	to	1	00
10.	Gray aluminous shale with small seams and partings of coal to the Chester beds	20	to	10	00
				141	00

DESCRIPTION OF CONNECTED SECTION.

The glacial phenomena in this county are obvious and interesting. Along the eastern side of the district under consideration, the soft Chester sandstone, 20 to 90 feet thick, are exposed. When the great ice flow came down from the north, this stone, more easily worn than the Conglomerate, was largely eroded, while the latter, presenting an obdurate and unflinching wall against the ice, caused deep wide valleys and valley plains to be formed, which extend from north to south, through the county, and east of Cloverdale, and conducted the masses of ice and water south to White river and Eel river near Cataract, giving origin to the Lacustral valley near Quincy, in Owen county. Many outlying hills and solitary knobs survive, measuring the amount of denudation, and showing the stratification of the companion rocks, now removed. From the tops of some of the hills, near and west of Cloverdale, extensive views may be enjoyed, reaching over the wide valley plains to the commanding hills at Cataract. On W. B. Williams' farm, northwest quarter, section 28, township 13, range 4, two

miles south of Putnamville, the Conglomerate sandstones still show the scars and striæ* of the glacier track, while the limestones north of Greencastle are still more plainly marked.

These few remarks must suffice for a mere reconnoisance. The county, as a whole, presents some of the most interesting evidences of the glacial age, including, besides the rock striations already mentioned, beds of lacustral and glacial drift, and the erosion, to a depth of over 120 feet below the present channel, of the ancient bed of Big Walnut and Croy's creeks.

A single outcrop was seen near the top of one of the highest eminences in the county, on Aaron Bales' land, northwest quarter of section 34, township 13, range 4, that appeared referable to seam B, No. 3 of section. It was opened by a drift 200 or 300 feet long. The mine was not in work, and the supports had fallen in so that measurements could not be made; the coal was reported to be three feet thick at the best pocket, with an average of less than two feet. It contains some sulphur, and is not desirable for smiths use, but burns well in grates. There is no probability of finding this seam in this county sufficiently developed to pay for working. The Conglomerate sandstone, No. 6 of section, in heavy beds or massive ledges is well developed in this district, forming the surface rock and the steep bold bluffs of the valleys. It is a coarse red or yellow ferruginous sandrock, excellent for walls, foundations and other hammered masonry, and at several stations good grits and glass sands occur; but the abundance of other superior building stone overshadows its ordinary good fire and weather-proof qualities.

The aluminous shales at the base of the Conglomerate, No. 7 and 9 of section, is a pretty constant feature, and generally takes the place of coal A. When the latter is disseminated, thick beds of black slaty shale are found. Kidney ores of iron and bands of pyrites are generally present in this stratum.

*Course of striæ south, 10° west.

The subconglomerate coal A, No. 8 of section, occurs at intervals all over the district. At a few localities it attains a thickness, in small pockets, of two to three feet, but they are limited in extent to a few yards or rods; as a rule the seam is barren, or only one or two inches thick, and will probably not exceed an average of four inches. Irregular and inconstant, at the same time the coal is generally sulphurous and inferior. Money spent in mining at this horizen will not earn an average return of more than ten cents on the dollar. One of the most interesting features of this region is the frequent beds of subcarboniferous lime and sandstone exposed in all the ravines and valleys; their consideration belongs to a full survey of the county, and may be described in a future report.

LOCAL DETAILS.

In the vicinity of Cloverdale considerable research for coal and other minerals has been made. Six miles southwest of town, on the land of H. T. Weathers, northeast quarter of section 12, township 12, range 5, a very considerable outcrop of rich band and kidney iron ore was seen in a wild, deep, gorge-like ravine. In 1860 Mr. W. mined some 30 tons and sold it to the Watson furnace at Knightsville; it was found to be an excellent ore to mix as a flux with Missouri ore. It was delivered at Hamrick's station, on the Terre Haute and Indianapolis railroad, at five dollars a ton, which just paid expenses, and the project was, of course, abandoned. The following section is exposed:

SECTION AT WEATHERS' IRON BANK.

	Ft.	In.
Soil and clay	10	00
Shaly sandstone	12	00
Reported coal (B?)		08
Massive conglomerate	14	00
White soft conglomerate	8	00
Gray laminated conglomerate	9	00
Pyritous shale, with band and nodules of iron ore	11	00
Coal A 2 ft. to	1	00
Gray shale to Chester beds	4	00
	69	00

Coal A in thin outcrops is reported on Wrightson's and Turman's land, adjoining this section on the east. The under-clay of a coal was noticed near a school house on Jos. Herbert's land, northeast quarter of section 17, township 12, range 4. It is of good, if not superior quality, and is worthy of the attention of potters.

At Silas Riley's, northeast quarter of section 8, township 12, range 4, at the bottom of a ravine, just north of his residence, is a bed of siliceous shale, which encloses a great number of comical and eccentric concretions, presenting almost every imaginable shape. Northwest and west of Cloverdale, outcrops of coal are reported as follows:

COALS NEAR CLOVERDALE.

	Ft.	In.
Chamberlain, southwest quarter, section 26, township 13, range 4, A	1	00
A. Bales, northwest quarter, section 34, township 13, range 4. B	2	00
Secrest & Co, southwest quarter, section 7, township 12, range 4, A.	...	...
T. Hanna, northeast quarter, section 3, township 12, range 4, A		04
W. B. Williams, northwest quarter, section 28, township 13, range 4, A	3 ft. to	09
A. Lye, section 36, township 13, range 5, A		06

At nearly all these points, coal A is overlaid by massive Conglomerate 20 to 75 feet thick, and accompanied by considerable beds of iron ore. At W. B. Williams', seam A is irregular as usual, varying from two inches to small pockets three feet thick. From seven or eight openings on the Williams farm, it has been dug, and before the completion of the railroad, was even hauled in wagons to Indianapolis for blacksmiths.

Putnamville is noted for having extensive banks of superior stone. It is siliceous, compact, and furnishes choice paving, step and other building stone. Sills and door steps from this quarry have been in constant use at the main entrance of the Terre Haute House for thirty years, without appreciable wear. This is one of the most valuable quarries in the State. West of town, coal A, two feet thick, was mined for local use on the Sellars farm.

A mile south of Greencastle, Cemetery Hill is capped with decomposed Conglomerate. The following section was taken:

SECTION NEAR GREENCASTLE.

	Ft.	In.
Disturbed Conglomerate, with *Lepidodendron* and *Stigmaria*	20	00
Laminated sandstone	8	00
Thin coal		06
Shaly sandstone	12	00
Pyritous shale, with ironstones	8	00
Black slate and coal A?	3	00
Chester shales and sandstone, with coal plants and large pronged fucoides	31	00
Sub-carboniferous limestone in brook	10	00
	92	06

On the farm of Andrew Black, five miles west of town, the high hills are built up with Conglomerate, some of which furnish good, white, grit, stones.

SECTION AT ALEXANDER BLACK'S.

	Ft.	In.
Ferruginous Conglomerate, with "pipe" and "pot" iron ore	10	00
Heavy sandrock, with diagonal beddiug	15	00
Massive Conglomerate	35	00
Aluminous shale—"rock houses"	5	00
Black slate	2	00
Coal A	1	00
Fire-clay	2	00
Sub-carboniferous, to Walnut creek	95	00
	165	00

The hills in the vicinity of Reel's mills are capped with Conglomerate, exposing sub-carboniferous shales and limestones in the creek valley. In the extreme northwestern part of the county, the coal measure rocks are generally eroded by Raccoon creek, but outliers of Conglomerate sandstone are reported near Morton, with some beautifully preserved fern leaves and trunks, which mark the horizon of coal A.

In conclusion, sincere thanks are returned to that earnest scientist Prof. Tingley, Dr. Layman, W. B. Williams and J. B. Sackett for information and assistance.

OBSERVATIONS

ON THE

DEPTH AND TEMPERATURE

OF SOME OF

THE LAKES OF NORTHERN INDIANA.

BY G. M. LEVETTE.

INDIANAPOLIS, INDIANA, December 31, 1875.

PROF. E. T. COX, State Geologist:

Dear Sir: In compliance with your instructions of 1st of August, 1875, Caleb Cooke and myself proceeded to the north part of the State with the necessary apparatus, and seined, dredged and took soundings and temperature of the following named lakes: Lake Manitou, in Fulton county; Pine, Stone and Clear lakes in LaPorte county; Syracuse or Nine-mile, Eagle and Centre lakes in Kosciusko county; Bixell, Latta and Reservoir lakes in Noble county; Twin lakes in Lagrange county, and Crooked and James lakes in Steuben county. On all of which, together with notes on the aquatic molluscan fauna of that region, a detailed report is herewith respectfully submitted.

Yours truly,

G. M. LEVETTE.

REPORT.

Between two and three hundred lakes, varying from a few acres to ten square miles in area, lie within the boundaries of the State, north of Wabash river. Some of them are land-locked, having no visible outlets, or sources of supply, except the rainfall drained into them from the low, narrow, sandy shores and short valleys of the immediately adjoining country. Others are fed by springs and small streams, and have outlets connecting them with the rivers of that well watered region. A few contribute their surplus waters to Lake Michigan through St. Joseph river, others join Maumee through St. Mary's, some flow into Eel river, a number into Tippecanoe and Iriquois, while others help swell the sluggish current of the Kankakee.

These lakes are, without exception, mere basins or depressions in the glacial clay. No stratified rocks have been found in the bottom or on the shores in a single instance, but, on the contrary, the numerous deep bores which have been made in that region, from time to time, prove that from eighty to two hundred feet of glacial drift overlies the stratified rocks throughout the entire lake region of northern Indiana.

Wet, boggy marshes and small lakes which have become dry and arable within the memory of white men; extensive deposits of peat, from five to fifty feet in depth; blind lakes or bodies of water which are covered with a few feet of peaty soil, some of which sustain a growth of forest trees; the annually receding shores of many of the smaller lakes, and the perceptible yearly accumulation of "marl" or fresh water lime in the shallow portions of many of them, all lead to the inference that at no very distant period in the past, the lake area of this region was two or three times its present extent; and further, that if the agencies now at work continue to accumulate material on their shores and beds, not many centuries will elapse before these now

numerous and interesting gems of the landscape will be known only to the students of ancient geography.

Within the past few years a growing interest has clustered about these foot-prints of the glacial flood. The character and origin of the "marl" or chalk and other deposits on the bottoms and ancient beaches of these lakes have become matters of deep interest and searching inquiry; they have been dredged and seined with a hope of finding something "new to science," some reptile, fish or shell heretofore unnamed and undescribed; their oozy beds filtered and the residuum examined with patient care for some new form of microscopic life, and though no directly economic results are apparent to the toiling husbandman as he watches with suspicious distrust the enthusiastic collector, quietly bottling every "creeping thing" revealed by net or dredge; yet each discovery swells the sum of human knowledge, and ere many decades have been added to the past, this class of information will be in demand by the descendants of those who now regard the naturalist with more of scorn than admiration.

The recent successful cultivation of food fishes, in various parts of the world, has prompted inquiries respecting the permanent supply, depth, temperature and other conditions of some of the more important inland bodies of water, with a view of determining to what extent this comparatively new industry is adaptable to them. The wide spread and growing interest on the subjects named, led to the desire for a complete hydrographic survey of the State; but the limited means at the disposal of the State Geologist prevented more than initiatory steps in that direction during the past summer.

Mr. Caleb Cooke, one of the Curators of Peabody Museum, Salem, Mass., a gentleman of extended and varied experience in collecting and preserving natural history specimens for museum use, as well as for scientific study, was engaged to superintend the dredging and seineing. In addition to his wide experience, Mr. Cooke possessed a complete equipment for the prosecution of such work, and

being associated in the same Institution with Prof. F. W. Putnam, an arrangement was effected by which all the ichthyological material collected would be examined by Prof. Putnam, free of cost to the Geological Survey, and full suites of all the species collected, properly labeled, and returned to the State Museum at Indianapolis, and all new species figured and described for publication in this or a subsequent report.

Mr. Cooke's liberal supply of long, deep seines were almost useless here, as the statutes of our State forbid the use of any seine longer than fifteen feet. Due regard for the law prevented the enrichment of our State Museum with many rare and interesting specimens of fish, obtainable only beyond the available limits of a seine of standard legal length, however, with the aid of one assistant, the short nets were used to good advantage in narrow streams, small ponds, and in the shallow water near the shores of the lakes, and several thousands of the smaller fishes were taken, preserved in alcohol and sent to Prof. Putnam for identification.

Mr. Cooke used what is known as the "Naturalist's dredge," consisting of a rectangular iron frame, eighteen inches long by five wide, with the inner edges perforated for the attachment of a stout hempen bag or net with very small meshes; the outer edges of the iron frame were flanged so as to act as a scraper when dragged on the bottom. This dredge is attached to a half-inch rope and lowered into the water from a boat, and by the aid of an assistant, an expert oarsman to propel the boat, the dredge is dragged over the bottom; as the bag soon fills with ooze, mud, sand, gravel, or whatever constitutes the bottom of the lake, it is as often drawn up into the boat, the contents emptied into a sieve for examination and for the selection of specimens for preservation. Samples of the bottom of each lake dredged, were sent to the State Labratory for examination and report.

The writer was specially charged with the duty of ascertaining the depth and temperature of the lakes visited,

observations on the molluscan fauna, and the character of the lake beds and their shores.

The sounding apparatus used consisted of a conical, two-pound iron weight attached to a stout hemp cord, the cord having been carefully measured and knotted with register tabs at intervals of five feet. The thermometer used for taking the temperature of the water was purchased of Mr. James Green, of New York city, and is a self-registering, deep sea thermometer of the Miller-Casella pattern, originally constructed under the direction of the officers of the British Hydrographic Bureau. It consists of a glass tube in the form of the letter U, the left limb terminating in a large cylindrical bulb, which is encased in an outer and larger bulb of glass, partly filled with alcohol, which protects the inner bulb from the pressure of the water at great depths. The bend and both limbs contain mercury to about half their length; the left bulb is entirely filled with a mixture of creosote and water, which rests directly on the mercury; the bulb on the right limb is about one-fourth full of the same fluid, the upper three-fourths being empty, or rather containing the vapor of the liquid.

A steel index, about three-tenths of an inch long and small enough to move freely within the tube, rests on either end of the column of mercury; a hair is attached to and coiled about each of these indices, and acts as a spring to hold it at any point to which the rising column of mercury may ascend.

Before using the thermometer the steel indices are drawn down by a magnet until they rest on the ends of the U shaped column of mercury; the left end of the tube is graduated to Fahr. degrees from the top downward to mark a decreasing temperature; the right limb is graduated from the bottom upward to mark increasing heat; when the liquid expands in the left bulb, the column of mercury is driven *down* in the left and *up* in the right limb toward the partly filled bulb, carrying the index upward with it to the point of highest temperature then experienced, leaving the index in the left tube at the point from whence the

column of mercury began to recede. When the liquid in the left tube is contracted by loss of heat, the mercury falls in the right limb, leaving the index at the highest point attained by the warmer temperature, and rises in the left limb carrying the index, on that side, to the minimum reached by the falling temperature; thus it is seen that when the indices are drawn down on the mercury in both limbs and the thermometer sunk to the bottom of ocean, lake or well, and, after a few minutes, drawn up, the position of the indices record the limit to which the mercury has been forced by the extreme of heat or cold to which the instrument has been subjected.

To guard against breakage by violent contact with rocks or other objects, the thermometer is enclosed in a cylindrical copper case, perforated at top and bottom to allow the free passage of water over the surface of the instrument.

Miller-Casella thermometers with encased bulb are in use in the United States Coast Survey and the Hydrographic Bureau of Great Britain for all deep sea temperature soundings, and give such universal satisfaction that all old forms of temperature registering instruments have been laid aside. Thermometers of this pattern have been subjected to a pressure of 6,800 pounds to the square inch, at a depth of two and a half miles in the ocean, and not only returned to the surface unimpaired, but gave no reason for doubting the accuracy of the recorded temperature.

On the arrival of Mr. Cooke from the east, we made all necessary provisions for successfully conducting the work, and proceeded to

LAKE MANITOU IN FULTON COUNTY.

This lake lies one mile southeast of Rochester, the county seat, and is about five miles long by one or one and a half miles wide, is irregular in outline, the west shore jutting into the lake giving it somewhat of a crescent shape. Two small islands break the monotony of its surface, one of which is inhabit Wild rice, *Zizania aquatica*, and

water lilies, *Nymphæa odorata* and *Nuphar advena*, grow in the shallow water near the shores and around the islands. Mill creek, a tributary of Tippecanoe river, enters the lake at the southwest corner and flows out at the north end, where a dam has been constructed, raising the surface level of the lake about nine feet; the water is conducted through a race-way along the bluff, one and a half miles, to the town of Rochester, where it has a fall of twelve feet, and affords sufficient power to run a flouring mill. The shores of Manitou lake are of gravel and glacial clay, with a few inches of well washed sand overlying the clay. In this, as in all other lakes visited in northern Indiana, the bed of the lake is of tenacious, compact clay, varying in color from white, through yellow to dark blue. From these puddled depressions, the water cannot escape, except by evaporation. A generous, annual growth and decay of aquatic plants in the shallow parts of the lake has covered the bottom, in places, with a black, slimy ooze; this annual deposit will eventually raise the bottom above the water level and gradually contract the lake area until only a sluggish rivulet, meandering through a flat, fertile meadow, will mark the site of the present broad and beautiful lake.

At the time white men first visited this section of country it was inhabited by the Pottawattamie Indians, and from that tribe came the name of the lake and the legend which gave rise to it. They believed this body of water to be the home of "*Manitou*," or "Bad Spirit;" that during heavy storms and certain nights in the dark of the moon, he might be seen disturbing and tossing the water, and, in defiance of repeated warnings, a number of dauntless "braves" of the tribe, who ventured to the shore of the lake after nightfall, were never heard of afterward. So firm was their faith in this musty and absurd tradition, they would not venture upon the lake in canoes, or eat fish taken from it.

Bass and pickerel are abundant in lake Manitou, and afford fine sport for those who have the patience to while away their time watching a cork dance idly on the wind-rippled water.

With the assistance of Robert Jewell, Esq., who lives on the west shore of the lake, and keeps for the use of sportsmen a full equipment of boats, spears, jacks, lines, and everything pertaining to fishing and gunning, we proceeded to sound and dredge the lake, and collect specimens for the State Museum.

On the west side of the lake, near the north end, soundings were made and temperature taken as follows:

1st.	Bottom at	20	feet,	temperature	62°	F.
2d.	"	30	"	"	58°	"
3d.	"	30	"	"	58°	"
4th.	"	34	"	"	57°	"
5th.	"	28	"	"	59°	"
6th.	"	30	"	"	58°	"

Returning as near as possible to the 4th station, serial temperatures were taken at intervals of five feet:

Temperature of the air at 9 P. M		56° F.
" surface water		65° "
" the water at depth of	5 feet	64° "
" " "	10 "	64° "
" " "	15 "	63° "
" " "	20 "	62° "
" " "	25 "	60° "
" " "	30 "	58° "
" " "	34 " bottom	57° "

From this point we moved to the south of the principal island, passing through shallow water where the prolific growth of water grass and wild rice (*Zizania aquatica*) rendered it difficult to row the boat; reaching deeper water at the south end, near where Mill creek flows into the lake, temperature soundings were taken with the following results:

1st.	Bottom at	20	ft., temperature	58½°	F.
2d.	"	32	"	53°	"
3d.	"	15	"	63°	"
4th.	"	20	"	59°	"
5th.	"	24	"	54°	"
6th.	"	26	"	54°	"
7th.	"	22	"	60°	"
8th.	"	18	"	61°	"
9th.	"	25	"	54°	"
10th.	"	38	"	51°	"
11th.	"	42	"	50°	"

At the last station, No 11, serial temperatures were taken at five foot intervals, as follows:

Temperature of the air at 8 A. M.					66°	F.
"	surface water				65°	"
"	the water at depth of 5 feet				65°	"
"	"	"	10	"	64°	"
"	"	"	15	"	63°	"
"	"	"	20	"	59½°	"
"	"	"	25	"	54°	"
"	"	"	30	"	53°	"
"	"	"	35	"	52°	"
"	"	"	40	"	50½°	"
"	"	"	42	" bottom.	50°	"

The above tests for temperature were repeated at 10, 20, 30 and 42 feet with confirmatory results. The surface temperature of the shallow water in the mouth of the creek was 66° F. Moving east from this point, the temperature of the bottom was taken, at intervals of about one hundred yards, with the following results:

1st.	Bottom at	18 ft.,	temperature	64°	F.
2d.	"	20	"	60°	"
3d.	"	17	"	61°	"
4th.	"	17	"	61½°	"
5th.	"	25	"	54½°	"
6th.	"	21	"	60°	"
7th.	"	18	"	62°	"
8th.	"	14	"	63°	"
9th.	"	25	"	54½°	"
10th.	"	28	"	54°	"
11th.	"	28	"	53½°	"
12th.	"	31	"	53°	"
13th.	"	28	"	53½°	"
14th.	"	25	"	54½°	"

Beyond which we run into shallow water with surface temperature at 68°.

Meanwhile Mr. Cooke, with the assistance of Mr. Jewell, Jr., had dredged the lake bottom at several points and bottled samples of the ooze, and collected, in great numbers, several species of the small fishes.

The mollusca observed in this and other lakes will be treated on at the end of this report.

Next in order, of the lakes visited, were those of LaPorte county. Within two miles of the town of LaPorte are seven lakes, all of which are land-locked, having no visible source of supply or drainage. A few of the number, locally called "Muckshaw," are rapidly filling with the roots and decaying tops of an enormous growth of lilies, arrowheads and aquatic grasses; all are being encroached on and through the agency of vegetal growth, will, in time, become swampy marshes—wet, peaty meadows—dry, arable land.

PINE LAKE, LAPORTE COUNTY.

This lake lies about a mile northwest of LaPorte, and is one of a chain of adjacent lakes recently connected by ditches through the natural ridges or embankments which separated them. This body of water is about one mile long, in a north-south direction, and nearly three-quarters of a mile in width. On the east and west sides, the hills are from thirty to forty feet in hight, and composed almost entirely of sand. The bed of this lake, with its substratum of stiff, blue clay, is no exception to the rule, although the superimposed deposit of sand on the shores is of greater depth than at any other lake in this region.

With the aid of one assistant, Mr. Cooke was very successful in securing representative specimens of the fishes, turtles and reptiles of this and neighboring lakes.

Temperature soundings were taken over Pine lake, beginning on the east side, near the garden landing of Mr. Allen, about five hundred feet from the shore, and moving north; depth and temperature, at intervals of about three hundred feet, as follows:

1st.	Bottom at	41	feet,	temperature	59°	F.
2d.	"	34	"	"	61°	"
3d.	"	20	"	"	63°	"
4th.	"	17	"	"	64½°	"
5th.	"	12	"	"	67°	"
6th.	"	10	"	"	67°	"
7th.	"	14	"	"	66°	"
8th.	"	38	"	"	60°	"
9th.	"	40	"	"	61°	"

10th.	"	39 "	"	....	61° "
11th.	"	30 "	"	....	62° "
12th.	"	25 "	"	....	64° "
13th.	"	40 "	"	....	61° "
14th.	"	12 "	"	....	66½° "

Returning to 9th station, serial temperature soundings were taken at intervals of five feet, as follows.

Temperature of the air at 9 A. M.		....	62° F.
"	surface water	....	68° "
"	water at depth of	5 feet..................	66° "
"	"	10 "	66° "
"	"	15 "	65½ "
"	"	20 "	65° "
"	"	25 "	63° "
"	"	30 "	61° "
"	"	35 "	61° "
"	"	40 "	59° "

Proved the above at 15, 30 and 40 feet. Moved toward southwest corner of the lake, taking depth and temperature as follows:

1st.	Bottom at	50 ft.,	temperature	....	56° F.
2d.	"	40	"	....	61° "
3d.	"	45	"	....	59° "
4th.	"	42	"	....	60° "
5th.	"	38	"	....	61° "
6th.	"	30	"	....	62° "
7th.	"	52	"	....	55° "

Took serial temperatures at the last station, as follows:

Temperature of the air at 11 A. M			....	70° F.
"	"	surface water	....	68° "
"	"	water at depth of	5 feet........	68° "
"	"	"	10 "	67° "
"	"	"	15 "	66° "
"	"	"	20 "	65½° "
"	"	"	25 "	64° "
"	"	"	30 "	62° "
"	"	"	35 "	62° "
"	"	"	40 "	61° "
"	"	"	45 "	58° "
"	"	"	50 "	55° "
"	"	"	52 "	55° "

The above temperature record was proved at 20, 30, 40 and 52 feet.

CLEAR LAKE, LAPORTE COUNTY.

This lake lies north of and adjoining the town, and is one mile across in either direction. It has uniformly low, sandy shores, and sustains a scattered growth of vegetation in the shallow portions. The water owes its turbid, dirty green color to the great quantity of suspended organic matter, confervæ, and perhaps minute animal organisms.

This being the first lake in the group to freeze over on the approach of winter, as stated by the citizens, it also proved upon investigation to be the shallowest. As no congelation can occur on the surface of a body of water until the whole mass has been reduced to the greatest density of fresh water, which contracts uniformly with the falling temperature to 0° C., it follows that the shallower a lake, the less protracted the term of low temperature required to reduce it to the freezing point.

The higher temperature attained in summer by the waters of these land-locked lakes is solely due to direct radiation of the sun's rays, and, as on the approach of winter the obliquity of the rays, their partial obscuration by prevailing clouds and the reduced length of the days, all aid in modifying the daily supply of heat, which is rapidly carried off by cold winds, the surface water is contracted by reduced temperature and displaces the warmer water below, which is thus brought to the surface to impart its heat to the colder air. This motion or convection of the particles is kept up until the whole vertical depth of water is brought to its greatest normal density, and at the moment of freezing it expands sufficient to keep it from sinking, after which convection ceases and the ice is thickened by radiation of heat through the congealed surface, into colder air above.

Since storing ice for summer shipment to southern markets has attracted attention in LaPorte, Clear lake has been observed to be the first of the group to freeze over and afford ice of proper thickness for storing. Just west of the centre of this lake, for a space of two or three acres, the water is only a few inches deep; this may have been

a small hill in the original bed of the lake, but the fishermen insist that it has formed there within a few years; that being true and no currents in the lake, the cause of the accumulation is not clearly understood.

A careful search with the sounding line, for half a day, failed to find any water more than nine and a half feet deep, Forty-two soundings were made, showing from four to nine and a half feet of water, and the temperature ranged from 66° at the surface to 65° at the bottom, in deepest parts.

Notwithstanding the high temperature of this shallow basin of turbid water, it is more resorted to for line fishing from boats than any other lake in the vicinity.

STONE LAKE, LAPORTE COUNTY.

This lake, the last one visited in this vicinity, lies about two miles northwest of town, is about three-quarters of a mile in length, and nearly as wide. It is nearly surrounded by sandy hills from twenty to forty feet high, and is one of the most beautiful sheets of water in the county; the south shore affording sites for four or five suburban residences. Why it should be called "Stone" lake is quite incomprehensible, as no rock of any description is visible in or near it; not a single pebble was seen in the clean, well-washed sand which constitutes the bottom, the shores and the adjacent hills. The water is very free from suspended matter, and so clear that shells can be distinctly seen resting in their oozy bed, under twenty feet of water.

All the eastern half of the lake is shallow, varying in depth from six to ten feet; over a great part of which aquatic grasses are growing luxuriantly, reaching, in many places, to the surface of the water. In the western half of the lake, near the high, bold shore, the water is deeper, reaching forty-two feet at the deepest point found by the sounding line.

Beginning near the eastern margin and moving westward, bottom soundings with temperature, were taken, as follows:

1st.	Bottom at	8	feet, temperature	69½° F.
2d.	"	8	" "	69½° "
3d.	"	9	" "	69° "
4th.	"	18	" "	68° "
5th.	"	28	" "	66° "
6th.	"	32	" "	56° "
7th.	"	36	" "	56° "
8th.	"	30	" "	56° "
9th.	"	33	" "	56° "
10th.	"	41	" "	55½° "
11th.	"	41½	" "	55½° "
12th.	"	39	" "	56° "
13th.	"	33	" "	56° "
14th.	"	40	" "	55½° "
15th.	"	42	" "	55½° "
16th.	"	38	" "	56° "
17th.	"	36	" "	55½° "
18th.	"	39½	" "	55½° "
19th.	"	33	" "	57½° "

Returning to station No. 15, serial temperatures were taken at intervals of five feet:

Temperature of the air at 2 p. m		72° F.
" " surface water		69½° "
" " water at depth of	5 feet	69° "
" " " "	10 "	68½° "
" " " "	15 "	68½° "
" " " "	20 "	67½° "
" " " "	25 "	66° "
" " " "	27 "	66° "
" " " "	28 "	66° "
" " " "	29 "	56° "
" " " "	30 "	56° "
" " " "	35 "	55½° "
" " " "	40 "	55½° "
" " " "	42 "	55° "

The above records were repeated with the same results at 20, 25, 27, 28, 29, 30, 40 and 42 feet. Between 28 and 30 feet the thermometer fell 10° and was lowered to about that point several times, but no intermediate temperature was recorded. This fall of 10° in temperature after passing a depth of 28 feet, was observed at other points in the lake, from one to two hundred yards from station 15, where the above serial record was made.

Mr. Cooke and assistant made a trip to Kingsbury in the southern part of LaPorte county, and seined with good success in a small stream tributary to Kankakee river.

While in La Porte, we received special aid and attention from John Sutherland, Dr. T. Higday, H. C. Noe, W. H. Weller, and Messrs. Axtell and Bridges of the Teegarden House.

CENTRE LAKE, KOSCIUSKO COUNTY.

Centre lake lies north of and adjoining the town of Warsaw, and is about one mile long by half a mile across. It is fed by a small tributary of Tippecanoe river, which flows out of the west side of the lake and joins the river after a tortuous course of two or three miles. The low shores and bottom are sandy; lilies and water grasses have secured a firm root-hold in all the shallow parts.

Through the kindness of Judge J. H. Carpenter and Dr. F. Moro, boats were procured, and in the face of a cold, high wind and approaching storm we proceeded to take soundings and temperatures in different parts of the lake. From the west side toward the middle, thence northward, the following observations were recorded:

1st.	Bottom at	36	feet, temperature	....	51½° F.
2d.	"	40	"	....	50½° "
3d.	"	35	"	....	51½° "
4th.	"	10	"	....	66½° "
5th.	"	20	"	....	66° "
6th.	"	30	"	....	55½° "
7th.	"	42	"	....	51° "
8th.	"	40	"	....	51½° "
9th.	"	30	"	....	51½° "
10th.	"	42	"	....	51° "

The high wind caused the boat to drift rapidly to the south, which rendered it quite impossible to fix the stations at regular intervals or equal distances apart; however, the following serial temperatures were taken at intervals of five feet vertically, as nearly as practicable, in the deepest water found:

Temperature of air at 4 P. M.				56°	F.
"	surface water			69°	"
"	water at depth of	5	feet	68°	"
"	"	10	"	67°	"
"	"	15	"	66°	"
"	"	20	"	65½°	"
"	"	25	"	61°	"
"	"	30	"	55½°	"
"	"	35	"	51½°	"
"	"	40	"	51½°	"
"	"	42	"	51°	"

The second trial at 25 feet gave 58°, but the wind had, at that time, increased to such a gale that further work was impracticable.

EAGLE LAKE, KOSCUISKO COUNTY.

Is one and a quarter miles south of Warsaw, is two miles long from north to south and three-quarters of a mile wide. The vast accumulation of peat on the sloping shores indicate a water-level, in past time, several feet higher than at present. A heavy growth of marsh grass, on the eastern margin and at the south end, is gradually invading the water area by a slow accumulation of peaty matter, and although this was the deepest body of water visited, the time can not be very remote when its bed will be raised to the level of the adjoining arable meadows.

A small stream, having its source in the higher lands to the south, flows through this lake, and in its course, through Centre lake and thence to Tippecanoe river.

About the year 1860, some citizens of Warsaw introduced White fish (*Coregonus albus*) into Eagle lake from Lake Michigan; they are occasionally caught here, but have never become abundant. Lake herrings (*Argyrosomus sisco*, Jordan), closely allied to white fish, abound in all the lakes tributary to Tippecanoe river. They leave the deep water of the lakes in November, and pass into the small streams to spawn, at which time great numbers can be taken with a short seine or dip-net. They bear salting, and are much esteemed by the citizens in the vicinity of streams where they occur.

After the storm of the preceding day had passed, though still too cold and windy for pleasant or reliable work, we visited Eagle lake, equipped for taking soundings and recording the temperature of the water. Starting from the the north end of the lake and moving southward, the following records were made:

1st.	Bottom at 35 feet, temperature	....	50°	F.
2d.	" 37 "	....	50°	"
3d.	" 50 "	....	49½°	"
4th.	" 74 "	....	47°	"
5th.	" 78 "	....	46½°	"

Serial temperature soundings were taken at station 5, at intervals of ten feet, with the following results:

Temperature of air at 3 P. M	....	52°	F.
" surface water	....	66½°	"
" water at depth of 10 feet	....	65½°	"
" " " 20 "	....	63½°	"
" " " 25 "	....	56°	"
" " " 30 "	....	53°	"
" " " 40 "	....	49°	"
" " " 50 "	....	48°	"
" " " 60 "	....	47½°	"
" " " 70 "	....	47°	"
" " " 78 "	....	46½°	"

Repeated and confirmed at 20, 30, 50 and 78 feet.

Moving from centre towards west side of lake, the following records were made:

6th.	Bottom at 62 feet, temperature	....	47°	F.
7th.	" 58 "	....	48°	"
8th.	" 76 "	....	47°	"
9th.	" 70 "	....	47°	"
10th.	" 50 "	....	48½°	"

A more thorough and detailed survey of this deep water-basin was desirable, but the wind had increased so as to render the boat unmanageable for accurate soundings, and being unprovided for so great a fall in temperature, we were reluctantly compelled to return to Warsaw.

Going north from Warsaw to Syracuse, in Kociusko county, a number of lakes were passed, but want of time and

local conveniences prevented any attempt to dredge or sound them.

SYRACUSE OR NINE-MILE LAKE, KOSCIUSKO COUNTY.

This lake, as it name implies, is nine miles long, from north to south, and from one to one and a half miles wide; it lies south of and adjoining the town of Syracuse, a station on the Baltimore, Pittsburg and Chicago railroad. This is a wide expanse of shallow water, over nearly the whole of which, wild rice and water grasses, annually make a luxuriant growth; at many places, near the shores, in the shallower water, the growth of rice is so heavy that propelling a boat with oars is quite impossible. This dense growth of vegetation in the lake and adjoining marshes affords fine cover and feeding grounds for water fowl, and for duck, snipe and rail shooting the place is widely and favorably known among sportsmen. White, black and striped bass (*Roccus*) and pike (*Esox americanus*) grow to good size here and are taken in abundance.

The lake is bordered on the east by an extensive marsh, which is, in turn, skirted by bluffs of glacial clay from thirty to fifty feet in hight. The shores and bottom are of sand, which is reported to be from one to five feet deep, with a sub-stratum of blue clay. Elkhart river conducts the surplus water into St. Joseph river on its way to Lake Michigan.

Soundings were taken in the north end of this lake with the following results:

1st.	Bottom at	22	feet,	temperature	....	59° F.
2d.	"	25	"	"	....	59° "
3d.	"	28	"	"	....	58½° "
4th.	"	30	"	"	....	58° "
5th.	"	28	"	"	....	58° "
6th.	"	35	"	"	....	57° "
7th.	"	36	"	"	....	57° "

Serial temperature soundings were taken at the last station with the following results;

Temperature of air at 9 A. M.				58° F.
" surface water				64° "
" water at depth of	5	feet		61½° "
" " "	10	"		61° "
" " "	15	"		60° "
" " "	20	"		59° "
" " "	25	"		58½° "
" " "	30	"		58° "
" " "	35	"		57° "
" " "	36	"		57° "

The above record was proven at 20, 30 and 36 feet.

While at Syracuse we were placed under obligations, for courtesy and attention, to D. C. Kelley, M. D. Mr. Wynant, druggist, Evan Miles, Esq., and the editor of the paper, to whom an apology is due for failing to remember his name.

RESERVOIR LAKE, ROME CITY, NOBLE COUNTY.

This is an artificial lake formed by a dam thrown across a small tributary of Elkhart river, for hydraulic purposes. This lake is near three miles long by half a mile in width; several islands, supporting groves of native timber, are enclosed; these charmingly cool, shady retreats, are very popular with pic-nic parties from neighboring towns. The Grand Rapids and Indiana railroad, extending from Fort Wayne, Ind., into western Michigan, passes through Rome City. Reservoir Lake and the Lake Side House are within a stone throw of the depot. I. N. Berry, proprietor of the hotel, to whom we are under obligations for special attentions, keeps a full equipment of boats and fishing tackle for the use of pleasure parties and sportsmen.

There being fifteen lakes and many thousands of acres of meadows and marshes within a few miles of this place, it is widely known and popular with Waltonian experts, and lovers of snipe and duck shooting.

The lake is not deep, as will be seen by the following record of soundings:

1st.	Bottom at	18	feet, temperature	....	57½° F.
2d.	"	16	"	....	57° "
3d.	"	17	"	....	57½° "
4th.	"	21	"	....	57° "
5th.	"	25	"	....	57° "
6th.	"	22	"	....	57° "
7th.	"	23	"	....	57° "
8th.	"	22	"	....	57° "
9th.	"	17	"	....	57½° "

Returning to station 5, serial temperature soundings were taken at intervals of five feet:

Temperature of air at 11 A. M			....	70° F.
"	surface water		....	61° "
"	water at depth of	5 feet	....	60° "
"	" "	10 "	....	59° "
"	" "	15 "	....	58° "
"	" "	20 "	....	57½° "
"	" "	25 "	....	57° "

About one mile southeast of Reservoir lake, and farther up the same stream, lies

LATTA LAKE, NOBLE COUNTY.

This is a small body of water of about sixty or eighty acres extent, nearly surrounded by hills rising from thirty to fifty feet above the water level. The wide margin of peat bog which skirts the lake indicates an expanse, in past time, of many times its present area.

The ancient lake shore, outside and above the peat bog, is made up of sand and fine, white gravel, beneath which blue clay is exposed in the roadways and ditches.

Moving from the east end of this lake to about the middle, soundings were made as follows:

1st.	Bottom at	16	feet, temperature	....	58½° F.
2d.	"	18	"	....	58½° "
3d.	"	26	"	....	57° "
4th.	"	28	"	....	56½° "
5th.	"	28	"	....	56½° "
6th.	"	33	"	....	56° "
7th.	"	30	"	....	56½° "
8th.	"	34	"	....	56° "
9th.	"	29	"	....	56½° "

Returning to station 8, the temperature was taken at intervals of five feet, from the surface to the bottom:

Temperature of air at 3 P. M.		68°	F.
"	surface water	60°	"
"	water at depth of 5 feet	60°	"
"	" " 10 "	59°	"
"	" " 15 "	58½°	"
"	" " 20 "	58°	"
"	" " 25 "	57°	"
"	" " 30 "	56½°	"
"	" " 34 "	56°	"

TWIN LAKES, LAGRANGE COUNTY.

These are two small lakes separated by a bar of sand, marl and gravel, about five hundred feet across. The presence of marl and an infinite number of fragments of of mussel shells in this sandy bar, point to a time not very remote when these Twins were one continuous sheet of water. The low shores on the north and east are sandy, while on the south margin of the larger lake, vegetal growth has built up a respectable peat bog. The latter, in which soundings were taken, is a mile and a half in an east-west direction, and from a quarter to a half mile in width. A heavy growth of rushes (*Juncus?*) and other water-loving vegetation has set in on both sides; over a great portion the water is from two to five feet in depth, but at the west end a long strip of deeper water was found, the soundings and temperature of which is here recorded.

Temperature of air at 3 P. M.		64°	F.
"	surface water	60°	"
"	water at depth of 5 feet	58½°	"
"	" " 10 "	57°	"
"	" " 15 "	57°	"
"	" " 20 "	56°	"

Several subsequent observations in other parts of the lake confirmed the above record.

CROOKED LAKE, STEUBEN COUNTY.

This lake is located about five miles northwest of Angola, the county seat, is between two and three miles long, by

about one mile in width, and has low sloping shores, which rise to twenty or thirty feet above the present water level; the north and east shores are sandy, and the shallow marginal water is quite free from vegetation, while all along the south side, aquatic plants have secured strong root-hold, and are seen rising a foot or more above the surface of the lake.

In this lake the deposition of lime (locally called "marl,") from the water, by the action of light and vegetal growth, may be studied to advantage. The water is of crystal clearness, and objects on the bottom, under ten or fifteen feet of water, may be distinctly seen; mussels (*Unionidæ*) are very abundant, and the posterior part of the shells, through which the breathing tubes project up into the water, are, in this lake, almost universally built up with a soft, pasty deposit of lime, varying in thickness from a half inch to an inch and a half, giving them the appearance of being much longer than they really are. This coating of lime excludes the light so completely that the epidermis beneath is a pale salmon hue, and without the rays and color markings peculiar to the species in running streams. The broken surfaces of stones, bits of wood, which, from partial decay, have sunk to the bottom, and the dead stalks of grass and weeds, are all coated with a film of lime. This incrustation appears to accumulate more rapidly in shallow water, where the sun's rays heat it more quickly and to a higher temperature, than in deeper portions of the lake.

A bottle of water was taken from this lake and sent to the laboratory at Indianapolis, an analysis of which is given on page 40 of this Report.

To a leaky boat, high wind and an inexperienced oarsman, may be charged the failure to reach the deepest point in Crooked lake, and acquire the information desired. The following record shows what was done; beginning on the east side and moving in a west course, soundings were taken as follows:

1st.	Bottom at 25 feet, temperature	....	55°	F.
2d.	" 28 " "	....	54°	"
3d.	" 30 " "	....	54°	"
4th.	" 28 " "	....	54½°	"
5th.	" 30 " "	....	54°	"

At the latter station serial temperature soundings were taken as follows.

Temperature of air at 2 P. M	....	64°	F.
" surface water	....	59°	"
" water at depth of 5 feet	....	58°	"
" " " 10 "	....	57°	"
" " " 15 "	....	56°	"
" " " 20 "	....	55°	"
" " " 25 "	....	54½°	"
" " " 30 "	....	54°	"

JAMES LAKE, STEUBEN COUNTY.

This lake lies one mile northeast of Crooked lake, is five miles long from north to south and from one-half to three-fourths of a mile wide. The east side of the lake is bordered by high hills, while the west side is approached over gently sloping meadows, cultivated to the waters edge; one or two small islands are enclosed by its waters. A heavy deposit of lime or "marl" on the west margin was, in the early settlement of that region, worked for lime for making mortar; the marl pits are still visible.

Lake James is quite celebrated for its fine fish, which are taken with hook or spear as the caprice of the sportsmen may determine. Lake herrings (*Argyrosomus sisco*, Jordan) occur in great numbers in this lake, and are seined in quantities from the small tributaries, where they go, in November, to spawn. Aquatic plants are encroaching on the water in almost all directions, giving the margins a marshy appearance.

We went on the lake from the west side, rowed to about the middle, and moving from thence south; soundings were taken as follows:

1st.	Bottom at	40	feet, temperature	....	55° F.
2d.	"	69	"	....	50° "
3d.	"	55	"	....	51° "
4th.	"	60	"	....	50½° "
5th.	"	50	"	....	53° "
6th.	"	64	"	....	50° "
7th.	"	70	"	....	49½° "

As station 7, serial temperature soundings were made, as follows:

Temperature of air at 4½ P. M........	62° F.
" surface water........	60° "
" water at degth of 5 feet........	58° "
" " " 10 "	57° "
" " " 20 "	56½° "
" " " 30 "	56° "
" " " 40 "	55° "
" " " 50 "	53½° "
" " " 55 "	52° "
" " " 60 "	50½° "
" " " 65 "	50° "
" " " 70 "	49½° "

Other trials confirming the above were made at 30, 50 and 70 feet.

Considerable time was spent rowing over the lake sounding for deeper water, but without success; at all subsequent soundings, the temperature, at corresponding depths, uniformly agreed with the above.

I am under great obligations to Messrs. Frank McCartney and Alvah Carpenter, of Angola, for aid and attention while in Steuben county.

BIXELL'S LAKE, NOBLE COUNTY.

This lake is situated east of and adjoining the town of Kendallville, and is about three-fourths of a mile long in a north-south direction, by a little less than half a mile in width. It has been much reduced in area by heavy accumulations of peat at the north and south ends. The west shore is sandy, and where the bottom was dredged up, it was composed of sand mixed with black muck or decomposed vegetal matter.

Beginning at the north end and moving south, soundings were recorded as follows:

1st.	Bottom at	25 feet,	temperature	55° F.
2d.	"	32	"	54½° "
3d.	"	28	"	55° "
4th.	"	35	"	54° "
5th.	"	41	"	53° "

The temperature of the water was taken at serial depths near station 5, in 41 feet of water:

Temperature of air at 10 A. M				66° F.
"	surface water			61° "
"	water at 5 feet depth			59° "
"	"	10	"	57½° "
"	"	15	"	56½° "
"	"	20	"	56° "
"	"	25	"	55° "
"	"	30	"	54½° "
"	"	35	"	54° "
"	"	40	"	53° "
"	"	41	"	53° "

Acknowledgements are due to James Colgrove, G. C. Glatte, Hon. Wm. Bunyan and C. O. Myers, editor of the Kendallville Standard, for favors and assistance while in Noble county.

MARL.

In a bluff about one mile north of Rome City, Noble county, on the land of Mr. Geisendorff of Indianapolis, a ditch has exposed a deposit of marl or fresh water chalk several feet in thickness. Other heavy deposits were reported in the same neighborhood. In the absence of a better article, this might be burnt and used for making mortar, but its chief value lies in its fertilizing properties when spread over the clay lands of the vicinity, after having been burnt and slaked.

An analysis of this marl is given on page 41 of this report. Containing over one-half per cent. of phosphoric acid, its value as a fertilizer, on land devoted to the growth of cereals, at once becomes apparent.

Many of the lakes throughout this region are bordered with similar deposits, varying from a few inches to twenty feet in thickness. The western shore of Lake James, in Steuben county, is a notable locality, and on the land of G. W. Slocum, in the same county, is a small lake, the shores which are almost wholly made up of this material, of a remarkable degree of purity, an analysis of which appears on page 41.

FOOD FISHES.

The lakes referred to in the preceding pages and many others within the State are, to a greater or less extent, stocked with several species of food fishes, among which the following are prominent:

Striped Bass, (*Roccus chrysops*).
Black Bass, (*Micropterus nigricans*).
Goggle Eye, (*Ambloplites rupestris*).
Croppie, (*Pomoxys annularis*).
Pickerel, (*Esox lucius*).
White Fish, (*Coregonus albus*).
Lake Herring, (*Argyrosomus sisco*).

The above are eagerly sought after by the citizens in the vicinity of the respective lakes, and great numbers are taken with hooks and spears, and in many instances, in violation of law, in fish baskets, traps and long seines. A few of the lakes, lying convenient to railway travel, are annually visited by hundreds of anglers from the cities of this and adjoining States. True Waltonian sportsmen seek for game fish only, and scorn those that will not take *live* bait; and to these there could be no objection if they would forbear during the spawning or "nesting" season.

Citizens living near the fishing grounds might do much toward increasing the quantity of the fish by rigidly enforcing the existing State Fish Law, prevent seining at any time and the capture or destruction of fish, by any means, during the time of spawning.

Dog Fish (*Amia calva*,) and Gar Pikes (*Lepidosteus osseus*,) occur in considerable numbers in some of the

TABULATED RECAPITULATION OF SERIAL TEMPERATURES.

DEPTH.	Eagle Lake.	James Lake.	Pine Lake.	Stone Lake.	Manitau Lake.	Bixell's Lake.	Centre Lake.	Syracuse Lake.	Latta Lake,	Crooked Lake.	Reservoir Lake.	Twin Lake.	Clear Lake.
Air	52	62	70	72	66	66	56	58	68	64	70	64	68
Surface water	66½	60	68	69½	65	61	69	64	60	59	61	60	66
5 feet		58	68	69	65	59	68	61½	60	58	60	58½	65½
10 "	65½	57	67	68½	64	57½	67	61	59	57	59	57	65
15 "			66	68½	63	56½	66	60	58½	56	58	57	
20 "	63½	56½	65½	67½	59½	56	65½	59	58	55	57½	56	
25 "	56		64	66	54	55	61	58½	57	54½	57		
28 "	54			66						54			
30 "	53	56	62	56	53	54½	55	58	56½	54			
34 "									56				
35 "	50½		62	55½	52	54	51½	57					
36 "								57					
40 "	49	55	61	55½	50½	53	51½						
41 "						53							
42 "					50		51						
45 "			58	55½									
50 "	48	53½	55										
52 "			55										
55 "		52											
60 "	47½	50½											
62 "	47												
65 "		50											
70 "	47	49½											
74 "	47												
78 "	46½												

waters of this State, and are terribly destructive to the young of all choice food fishes. It has been estimated by a shrewd observer on the shore of Lake Michigan, that the yearling White Fishes, annually destroyed by one medium size Dog Fish, would, as "three-year-olds," exceed a ton in weight. This added to the great increase in numbers, if allowed to spawn, gives a limited idea of the frightful cost of sustaining these piscivorous gormands, which, as well as the equally destructive Gar Pike, is always coarse, rank and unpalatable.

The question may be asked, why cannot the fish law be so modified as to allow, if not encourage, the destruction, at all times, of the two species above named?

Fully three-fourths of the lakes within the State are eminently fitted for the introduction of such species of the Salmonidæ as do not, from necessity, spend a portion of each year in salt water.

The National Government, through its efficient Fish Commissioner, Prof. Spencer F. Baird, is doing a grand work by stocking the larger streams and lakes of the United States with the better class of food fishes, and if seconded by State legislation for the protection of introduced species at proper seasons, the streams, once so full of native fishes, will soon again swarm with an abundance of wholesome, nutritious and palatable food. As the field of operations of the U. S. Fish Commissioner is as wide as the continent, and the means at his disposal quite limited, it would seem perfectly proper for our State or County authorities to solicit the co-operation of the Commissioner, and render local aid in the introduction, into some of the lakes in the State, of such non-migratory species as he may have for distribution.

MOLLUSCA.

The lakes of northern Indiana contribute to four distinct systems of drainage: through St. Joseph river into Lake Michigan, through Maumee river into Lake Erie, through

Kankakee river, across the State of Illinois, into Mississippi river, and through Wabash into Ohio river. Notwithstanding this wide scattering of the waters of these lakes, their molluscan fauna have many striking characteristics in common.

Nearly all the species observed are common to all the lakes and streams, while a few are more restricted in their range. One peculiar feature of all the lake shells is their extreme frailty—uniform want of weight and substance. The necessities of molluscan life in the quiet beds of currentless lakes may not demand the same weight and strength of external shell as required by their more exposed congeners in the gravelly beds of swift running streams. That there is no paucity of shell-building material present in the water is shown by the constant, generous deposition of nearly pure carbonate of lime on all the shells, sticks and decayed plant stocks, and in the heavy "marl" deposits on the borders of many of the lakes, and further, by an analysis of the water of James Lake, p. 40 of this Report, which shows seven grains of carbonate of lime in a gallon. *Unio luteolus*, Lam., a shell of very extended range, when taken in any of these lakes is found to be comparatively frail; having only about half the weight of shell of specimens of the same size taken from Wabash river, or its swift, gravel-bottomed tributaries.

This comparative frailty of shell in the Unios of the lakes was not observed in the Anodontas; that sub-genus is, as a rule, more prolific and grows to larger size in lakes and ponds than in flowing streams, but the amount of shell accumulated, by specimens, of a given size, from lakes and streams respectively, do not exhibit any marked difference.

Very few pustulate or rugose shells were observed in this region. In the gravelly parts of the northern tributaries of Wabash river *Unio verrucosus*, Bar. and *Margaritana rugosa*, Bar. are occasionally met with. In St Joseph river, St, Joseph county, *Unio pustulosus*, Lea, occurs sparingly, the specimens bearing a strong resemblance to *U. schoolcrafti*, Lea. In 1873, *U. kirtlandianus*, Lea, was taken

by the writer, from a small stream in DeKalb county, and dead shells of that species were afterward seen along a tributary of Tippecanoe river. *Unio occidens*, Lea, *U. ligamentinus*, Lam., *U. luteolus*, Lam., *U. pressus*, Lea, and *Anodonta edentula*, Say. are common to all the running streams of the region under consideration. *U. occidens*, Lea, *U. luteolus*, Lam., *Anodonta edentula*, Say, *A. plana*, Lea, *A. fragilis*, Lam., *A. imbecilis*, Say, are found in all the lakes. *Unio nasutus*, Say, was observed only in Lake Manitou, though there is no apparent good reason why they may not be found in all the lakes connected with that line of drainage.

The following is a list of the *Unionidæ* taken, by the writer, at different times, north of Wabash river:

Unio circulus, Lea, Eel river.
" *clavus*, Lam., Eel, St. Joe and Tippecanoe rivers.
" *fabalis*, Lea, Eel river.
" *glans*, Lea, Eel river.
" *kirtlandianus*, Lea, tributaries of Maumee and Tippecanoe rivers.
" *ligamentinus*, Lam., all the streams.
" *luteolus*, Lam., all the lakes and streams.
" *multiradiatus*, Lea, Eel and Tippecanoe rivers.
" *nasutus*, Say, Lake Manitou.
" *occidens*, Lea, all the lakes and streams.
" *pressus*, Lea, all the streams.
" *pustulosus*, Lea, St. Joe river.
" *rangianus*, Lea, Eel river.
" *spatulatus*, Lea, St. Joe river.
" *verrucosus*, Bar., tributaries of Wabash river.
Margaritana rugosa, Bar., Eel river.
Anodonta edentula, Say, all the lakes and streams.
" *fragilis*, Lam. all the lakes.
" *imbecilis*, Say, all the lakes.
" *plana*, Lea, all the lakes.

To John W. Byrkit, Esq., of this city, is due the credit of preparing the following list of fresh water Univalve

shells known to inhabit the lakes and streams in Indiana, north of Wabash river:

Limnæ stagnalis, Linn.
L. s. var. *appressa*, Say.
L. s. var. *jugularis*, Say.
Limnophysa reflexa, Say.
L. r. var. *exilis*, Lea.
L. r. var. *elodes*, Say.
L. desidiosa, Say.
L. catascopium, Say.
L. caperata, Say.
Physa gyrina, Say.
P. heterostropha, Say.
Bulimus hypnorum, Linn.
Helisoma trivolvis, Say.
H. t. var. *regularis*, Lea.
H. bicarinatus, Say.
Menetus exacutus, Say.
Gyraulus parvus, Say.
Valvata tricarinata, Say.
Vivipara contectoides, Say.

TESTUDINATA.

The following is a list of turtles known to inhabit this region:

Aspidonectes spinifer, Lesueur, soft shell turtle, Kankakee river and, possibly, all the lakes.
Chelydra serpentina, Linn., snapping turtle, all the lakes and larger streams.
Aromochelys odoratus, Lat., musk turtle, nearly all the lakes,
Aromochelys, sp.? Clear Lake, LaPorte.
Pseudemys hieroglyphica, Hol., hard shell, Kankakee river.
Malacoclemmys geographicus. Les., green head, Eel river, St. Joe. river.
Chrysemys picta, Herm., var. *marginata*, Agass, painted turtle, all the streams and lakes.
Nanemys guttatus, Schn. speckled back, ditches around Kendallville, and, doubtless, over the whole region.
Emys meleagris. Shaw, land turtle, sparingly in the northern parts of LaGrange and Steuben counties.

MOUNDS AND ANTIQUITIES.

Through the kindness of James Colgrove, of Kendallville, we were shown some mounds near Little Turkey

lake, in the southwest corner of Steuben county. One on the roadside, about ten feet in diameter, and ten feet high, had been opened; it was of coarse gravel and sand, the same as the surface soil in the adjoining field.

A few rods southeast of this, in the woods, we visited a well defined mound, twenty-five feet in diameter, and four and a half feet high; the centre had been dug out, a deeper excavation was made, reaching down to the level of the surrounding soil, without finding any bones, or other evidences of burial. About a quarter of a mile further south, on land of Frank Glascow, near the margin of a marsh, (ancient lake,) another mound was discovered, having about the same dimensions as the one last mentioned. An excavation was made in the top, and at the depth of three feet, ashes, charcoal, and fragments of human bones were found; about one foot below these another layer of ashes and charcoal was encountered, among which were the much decayed bones of an adult human being; associated with the pelvis bones were fragments ot a skull, jaw bones, and well preserved, but much worn teeth, indicating burial in a sitting posture. One stone implement was taken out—a chisel-shaped slab of mottled slate, four and a half inches long by two inches wide, and one quarter of an inch thick, with one corner broken off.

Subsequently Mr. G. C. Glatte, of Kendallville, took us eight miles north, to the farm of E. Shaddock, on west side of Cree lake, where, a group of seven mounds are located, on a tract of land of about twenty acres. The largest and central mound of the group is sixty feet in an east-west direction, and twenty-five feet north-south. Six others, of smaller dimensions, are located about the central mound, at unequal distances from it and each other, arranged without the least reference to any apparent plan or system.

With the assistance of Chas. Weingart, a neighboring farmer, two excavations were made in the largest mound, about twenty feet from either end. In each excavation, on the surface level upon which the mound was built, a human skeleton was found; in both instances, they were lying

with heads to the north on the right side, facing west. The bones had become so softened by long exposure in the ground that it was impossible to raise any single bone entire. In the east opening, Caleb Cooke, with patient care, removed the earth from about the cranium and took it up in pieces, which, after drying, were glued together, making the specimen almost entire. In the cranium, just referred to, the temporal bone, left side, had been crushed through, leaving an irregular hole about one and a half inches in diameter; within the skull, with the sand which filled the cavity, two small balls or cakes of clay were found of about the same diameter as the hole. Mr. Cooke suggested that the person might have met with a violent death and the clay was used as a dressing for the wound or to hide the ugly scar at the time of burial.

From the opening in the west end, the cranium was removed entire without disturbing the enclosed, compact, wet sand, it was carefully packed in sawdust and brought to the State Museum in good condition*. Evidences of fire—ashes, small bits of charcoal and calcined earth—were found in this mound, but no implements or vessels. Want of time prevented the examination of other mounds in this group.

Returning to Kendallville by another route, several mounds were seen on the bluff which skirts the marsh around Turkey lake, near Wolcottville, in Lagrange county.

Four miles southeast of Kendallville, on land of Mrs. Ann Field, there is an oval mound about one hundred and twenty feet the long way, eighty feet across and twenty-five feet high. It is in the woods and covered with trees of

*For the benefit of inexperienced persons who may undertake exhuming pre-historic skeletons, it may be stated that many interesting and valuable crania are wholly destroyed by attempting to take them up in pieces. The partially decomposed, wet bone is soft and spongy and readily disintegrates by careless handling; while, if taken up entire, its earthy contents act as a core or support, and if, before drying, it is packed in sawdust or earth (to exclude the air) and allowed to remain until the whole mass is dry, the bone will harden sufficiently to bear handling, after which the contents may be removed and the specimen preserved for study and comparison.

same size as those on adjacent land. About 40 rods distant there are several smaller mounds; some of which have been opened, yielding stone axes, arrow points, and fragments of charcoal.

Extensive systems of earth-works, often occupying commanding positions on hills, bluffs or bends in the streams; mounds of various sizes and forms, ascribed by writers, according to their fancy, to special uses, as: worship, sacrifice, burial, observation, signal or habitation; large areas enclosed by angular or circular embankments, often surrounded by or enclosing a number of smaller works, and nearly always located near streams or lakes, and when in a forest, sustaining trees as great in size and age as those adjacent; and nowhere, by ground plan or relation to each other, indicating any existing knowledge of the points of the compass. These mute, unlettered monuments of a vanished race, in a thousand modified forms, lie scattered throughout the Mississippi valley.

A few, perhaps a respectable number, of the archæologists of this day, have sought to show, from the identity of the stone implements taken from the mounds, with those made and used by existing tribes, that the Indians, found on this continent at the time of its discovery by Columbus, were lineal descendents of the Mound Builders. This conjecture, as probable and rational as any, is not sustained by the traditions, which are known to have been carefully (if not always truthfully) handed down from generation to generation, and which always omitted any knowledge of the great earth-works, or their builders.

Whether the Mound Builders perished as a race, and the Indians were subsequently introduced from other sources, or whether the Indians are directly descended from a mound building ancestry, are queries which, in the light of existing evidence, baffle investigators.

The age of trees found growing upon some of the earthworks, (in a few instances recording nearly nine hundred years,) only obscure the solution, by suggesting that they may have been planted by the Builders, or, that the works

may have been barren of arboreal growth, until after the race, which erected them, had ceased to exist. Dead centuries of unrecorded experience interpose a vast chasm between that mysterious people and ourselves, and dim, disconnected and unreliable are the few intelligible signs which span it

Science, flushed with its wonderful progress in the past few decades, stands mute and powerless over the abyss of time which separates us from the origin, life-history and destiny of that buried race. Archæologists have mapped the banks, trenches and tumuli, collected stone implements, unchanged from the hand of the artisan, filled museums with relics of their rude handiwork, and printed libraries of theories and suggestions; eminent men have devoted valuable lives to the study of their effects, yet over their life-history, habits, manners, customs, dress, food, language, origin and fate, reigns an infinitude of uncertainty.

CATALOGUE

OF THE

FLORA OF THE WABASH VALLEY

BELOW THE MOUTH OF WHITE RIVER,

AND OBSERVATIONS THEREON.

BY J. SCHNECK, M. D.

MT. CARMEL, ILL., Jan. 1. 1876.

PROF. E. T. COX,

State Geologist of Indiana:

SIR:—I have the pleasure of herewith presenting a catalogue of the flora of the lower Wabash valley, so far as I have ascertained, with notes on the distribution, frequency of occurrence, and time of flowering of plants found here; and such general observations as was thought would be of interest.

In order to make it more valuable to those of the readers of your Report who are not familiar with the scientific names of plants, I have thought it best (although in some respects objectionable and unreliable) to add, in parenthesis, the usually recognized common, and more extensive local names.

The identifications were made mostly by myself, but in every instance where there was the least doubt, I have

sent specimens to good authorities, in order to have the diagnosis as perfect as possible. I take great pleasure in here acknowledging my most sincere thanks to those gentlemen who have so kindly assisted me in this work.

Very respectfully,

J. SCHNECK.

INTRODUCTION.

The territory in which the plants, named in the following catalogue, have been found, comprises a part of the counties of Gibson and Posey in Indiana; and Wabash, Edwards, White and Gallatin, in Illinois. The greater portion of the work, however, has been confined to the first three counties named.

The region thus embraced presents a good variety of physical features, consisting of extensive river bottoms, hills, prairies, barrens, rocky bluffs, glades, copses and swamps, intersected with numerous small streams, ponds, lagoons and bayous (the two latter doubtless the remains of former beds of the Wabash river). The Wabash, meandering through it in a south southwest direction, is bordered the greater distance, on both sides, by a rich, alluvial, heavily timbered bottom land, extending back as far as ten miles in some localities, when it usually terminates in a steep range of very heavily timbered, rock-bedded hills; or, rising less abruptly, gradually passes into a prairie, or what was once a prairie or barrens, but is now covered with a luxuriant growth of young valuable forest. In some localities, however, the hilly or prairie lands commence at the river bank for a short distance, thus forming steep banks or rocky bluffs.

A physical feature that is very remarkable and gives a peculiar appearance and interest to these bottom lands, is the short isolated ranges of hills or upheavals, scattered through them at irregular intervals, varying in length

or breadth from one to three or more milee, in hight from fifty to one hundred and fifty feet; are usually very steep, forming in some instances extensive rocky cliffs. The timber growth is remarkably heavy on these ridges and appears to be coeval with that of the more extensive ranges; both are, or have been, covered by an unusually massive growth of timber, principally White Oak (*Quercus alba*), Tulip Tree (*Liriodendron tulipifera*) and Sugar Maple (*Acer saccharinum*), interspersed by an extensive variety of smaller trees, with a luxuriance and great abundance of annuals and perennials.

In strong contrast with these sudden elevations, nestled at their bases, are frequently found ponds, bayous and lakelets, sometimes several miles in extent. These are usually heavily fringed at their water's edge with such vegetation as is peculiar to muddy situations; prominently among them are: Arrow Head (*Sagittaria variabilie, S. heterophylla*), Pickerel Weed (*Pontederia cordata*), Mud Plantain (*Heteranthera reniformis*), Water Plantain (*Alisma plantago*, var. *Americanum*), &c. These in turn are overhung by a profusion of Willows (*Salix nigra*, and *S. petiolaris*), Button Bush (*Cephalanthus occidentalis*), Swamp Dogwood (*Cornus paniculata*), Spice Bush (*Lindera benzoin*), Red Birch (*Betula nigra*), &c., shading off into a deep forest of trees, whose lofty, limbless shafts appear as so many massive columns supporting the over-hanging canopy.

The annual freshets and overflows have, in many localities, deposited extensive sand ridges and drifts of wood, which add greatly to the primitive appearance of these woods. A closer examination of these small bodies of water proves them to be exceedingly rich in aquatic vegetation; here are found in abundance and luxuriance the Nelumbo (*Nelumbium luteum*), (I have measured a leaf, three feet three and one-half inches in diameter,) the lovely sweet-scented White Pond-Lily (*Nymphæa odorata*), Yellow Pond-Lilies (*Nuphar advena* and *N. sagittifolia*), Pondweed (*Potamogeton nataus* and *P. lucens*), Cabomba (*C.*

Caroliniana), Water Target (*Brasenia peltata*), &c. In other localities one suddenly emerges from the dense forests, into a grassy opening or glade, which is at once recognized as the remains of a pond or miry swamp.

It is but natural to conclude, that, situated as we are, near the central point in the great Mississippi valley, at an elevation varying from three hundred and fifty to six hundred feet above sea level, with a temperature ranging from $-24°$ to $+104°$, that our flora would be equally variable and rich in numbers of species. As an evidence of the variableness of our seasons, I will give my notes of the first leafing and first flowering of some of our earliest species, taken in the springs of 1872 and 1874. The winter of 1872 was unusually cold, the spring began late and suddenly. While the winter of 1874 was open and mild, spring began early, but it remained cold longer than usual. It will be noticed, there is considerable difference, until near the end of March, after which they run nearly the same the remainder of the spring.

NOTES.

NAMES.	Time of Leafing. 1872.	Time of Leafing. 1874	Time of Flowering. 1872.	Time of Flowering. 1874.
Red or Swamp Maple (*Acer rubrum*)	Apr. 12.	Mar. 28	Mar. 20	Feb. 15
White Maple, (*Acer dasycarpum*)	" 12.	" 31	Apr. 8..	....
Sugar Maple, (*Acer saccharinum*)	" 15.	" 20	....	Mar. 19
Wild Columbine, (*Aquilegia Canadensis*)	" 20.	....	....	....
Shagbark Hickory, (*Carya alba*)	" 13.	Apr. 10.	Apr. 20.	Apr. 15.
Red-bud, (*Cercis Canadensis*)	" 20.	" 15.	" 10,	" 15.
Flowering Dogwood, (*Cornus florida*)	" 20.	....	....	" 30.
Spring Beauty, (*Claytonia Virgnica*)	" 6.	Apr. 1...	Apr. 12.	" 15.
Japan Quince, (*Cydonia Japonica*)	Mar. 20	Mar. 10	Mar. 28	Mar. 20
Common Qcince, (*Cydonia vulgaris*)	Apr. 15.	Apr. 7...	....	....
Chestnut, (*Castanea vesca*)	" 18.	" 15.	....	Mar. 20
Wild Cherry, (*Cerasus serotina*)	....	" 20.	....	Apr. 14.
Common Cherry, (*Cerasus vulgaris*)	Apr. 15.	" 12.	....	....
Black Thorn, (*Cratægus tomentosa* var. *mollis*)	" 22	" 25.	....	....
Pepper-root, (*Dentaria laciniata*)	....	....	Apr. 10.	Apr. 4.
Dutchman's Breeches, (*Dentaria cucullaria*)	....	....	Mar. 22	Mar. 15
American Cowslip, (*Dodecatheon Meadia*)	....	....	Apr. 28.	Apr. 30.
Yellow Erythronium. (*Erythronium Americanum*)	....	....	" 5.	" 1.
Pepper-and-Salt, (*Erigenia bulbosa*)	....	....	Mar. 21	Mar. 12
Forsythia, (*Forsythia suspensa*)	Apr. 10.	Apr. 1...	" 21	" 15
Strawberry, (*Fragaria vesca*)	....	....	Apr. 15.	Apr. 12.
Spotted Geranium, (*Geranium maculatum*)	Apr. 20.	Apr. 15.	....	....
Liverwort, (*Hepatica acutiloba*)	....	....	Mar. 15	Mar. 15
False Rue Anemone, (*Isopyrum biternatum*)	....	....	Apr. 20.	Apr. 16.
Common Blue Flag, (*Iris versicolor*)	Apr. 30.	Apr. 28.	....	....
Dwarf Iris, (*Iris pumila*)	....	....	Apr. 5...	Apr. 1.
Tulip or Poplar Tree, (*Liriodendron tulipifera*)	Apr. 15.	Apr. 4...	....	....
Gromwell, (*Lithospermem latifolium*)	" 15.	Apr. 15.	....	....
Smooth Lung-wort; Blue Cell (*Mertensia Virginica*)	....	....	Apr. 20.	Apr. 20.
Black Gum, (*Nyssa multiflora*)	May 1...	May 2...	....	....
Box Elder, (*Negundo aceroides*)	Apr. 30.	Apr. 20.	....	Mar. 29
Red or Yellow Plum, (*Prunus Americana*)	....	....	Apr. 10.	Apr. 10.
Common Garden Plum, (*Prunus domestica*)	....	....	" 12.	" 8.

NOTES.

NAMES.	Time of Leafing.		Time of Flowering.	
	1872.	1874.	1872.	1874.
Apple, (*Pyrus malus*)	Apr. 13.	Apr. 12.	" 20.	" 25.
Pear, (*Pyrus communis*)	....	" 15.	....	" 15.
Sweet-scented Crab-tree, (*Pyrus coronaria*)	....	" 15	....	May 8.
May Apple, (*Podophyllum peltatum*)	Mar. 30	" 7.	....	....
Greek Valerian, (*Polemonium reptans*)	....	....	Apr. 15.	Apr. 10.
Sycamore, (*Platanus occidentalis*)	May 1...	May 3...	....	....
White Oak, (*Quercus alba*)	Apr. 13.	Apr, 12.	....	....
Water or Pin Oak, (*Quercus palustris*)	....	....	Apr. 17.	Apr. 15.
Red Oak, (*Querus rubra*)	Apr. 24.	Apr. 25.	" 18.	" 20.
Shingle or Laurel Oak, (*Quercus imbricaria*)	May 3...	May 2...	May 9...	May 12.
Black or Tanner's Oak, (*Quercus tinctoria*)	Apr. 28.	Apr. 25.	Apr. 17.	Apr. 20.
High Blackberry, (*Rubus villosus*)	" 20.	" 12.	....	....
Dog Rose, (*Rosa canina* var. *Burboniana*)	" 15.	" 7.	....	....
Carolina Rose, (*Rosa Carolina*)	" 14.	" 14.	....	....
Buttercup, (*Ranunculus abortivus*)	....	....	Apr. 15,	Apr. 10.
Common Lilac, (*Syringa vulgaris*)	Apr. 19.	Apr. 21.	" 12.	" 22.
Red Puccoon; Blood Root, (*Sanguinaria Canadensis*)	Mar. 20	Mar. 22	" 5.	" 2.
Elder, (*Sambucus Canadensis*)	" 18	" 16	....	....
Weeping Willow, (*Salix Babylonica*)	May 12..	May 14..	....	....
American Elm, (*Ulmus Americana*)	Apr. 28.	Apr. 25.	Mar. 20	Mar. 10
Black Haw, (*Viburnum prunifolium*)	Mar. 27	Mar. 25	Apr. 10.	Apr. 10.

A review of the accompanying catalogue cannot fail to impress one with the abundance of those species that are also common to the Southern States; notably among them are, Cross-Vine (*Bignonia capreolata*), Catalpa (*Catalpa bignonioides*), Trumpet Flower (*Tecoma radicans*), Pecan (*Carya olivæformis*), Pipe-Vine (*Aristolochia tomentosa*), Persimmon (*Diospyros Virginiana*), Sweet Gum (*Liquidambar Styraciflua*), Hackberry (*Celtis Mississippiensis*),

Bald Cypress (*Taxodium distichum*), Water Locust (*Gleditschia monosperma*), &c. This list could be extended until it included one-half of our flora.

The following is a list of plants found here, that are out of the habitat usually given them in text-books. It will be observed that most of them are southern:

Cabomba Caroliniana.
Nasturtium sessiliflorum.
Vitis indivisa.
Agrimonia parviflora.
Cynthia dandelion.
Hottonia inflata.
Chelone Lyoni.?
Potamogeton pectinatus.
Smilax glauca.
Eragrostis poæoides.
Aspidium acrostichoides.
Nuphar sagittifolia.
Hypericum Drummondi.
Polygala ambigua.
Gnaphalium purpureum.
Campanula divaricata.
Martinia proboscidea.
Potamogeton, gramineus, var. *spathulæformis.*
Pancratium rotatum.
Carex retrorsa.
Asplenium angustifolium.
Tilia heterophylla.

Nor is this deep tincturing of the southern types confined to the flora; but scattered through the various reports on the fauna of this district, are found many birds, reptiles, insects and mammals that are decidedly tropical in aspect and habitat.

A ramble through our woods can not fail to make this impression more convincing, not only by the great numbers of species that are common to the Southern States, but also by their unusually profuse and luxuriant growth. Here, I have found a Grape Vine (*Vitis labrusca*), thirty-two inches in circumference, and near one hundred and fifty feet long, hanging from the massive branches of a lofty tree, appearing as it a monstrous cable suspended from the

overhanging sky; Trumpet Vine (*Tecoma radicans*), thirty-eight and one-half inches in circumference, and climbing to the topmost branches of a tall tree, decorating it from root to top with a profusion of its foliage and orange-red trumpet-shaped flowers. Cross-Vine (*Bignonia capreolata*), ascending in a straight line the massive shaft of an oak, elm, or black walnut, to the hight of seventy-five feet, its green, scarlet-tinged foliage of winter persisting until late spring. Single-seed Cucumber (*Sicyos angulatus*), matting all bushes and vegetation, within ten feet of its root, into a thicket; or climbing up a neighboring tree to the distance of sixty-three feet. And in one instance six climbing plants (*Smilax rotundifolia, Menispermum Canadense, Ampelopsis quinquefolia, Bignonia capreolata, Vitis cordifolius, Aristolochia tomentosa*), supporting themselves on the body and branches of one small American Elm.

In the annexed table is given the maximum measurements of several of the most common species of trees. The measurements in each case are those of one individual.

The measurements can only be regarded as those of the remnant of a once extensive, luxuriant and exceedingly massive growth of forest trees. Could they be compared with those that might have been taken fifty or seventy-five years ago, they would doubtless be far surpassed. One can not suppress a sigh of regret over the many prostrate and decaying bodies of those grand old monarchs of the forest, whose venerable lives have been sacrificed, when in their fullest manhood and grandeur, by the indefatigable frontiersman, for a hive of honey-bees or a raccoon that has sought refuge and a home in the hollows of their bodies or massive limbs.

While the wasteful destruction of timber has been great, yet it can in no way be compared with the amount annually taken from those woods for useful purposes. Scattered through the country, and at almost every bend of the river, will be found saw mills; some of which have been almost daily doing the work of destruction for the last fifty years. And of late, the more ravenous, portable saw mills have gone to the more inaccessible localities, until there is scarcely

TABLE OF MEASUREMENTS.

NAME.	Circumference 3 feet from ground or above roots and swell.	Hight of trunk from root to first branch.	Total hight
Pecan, (*Carya olivæformis*)	16 feet.	90 feet.	175 feet.
Black Oak, (*Quercus coccina*, var. *tinctoria*)	20 "	75 "	160 "
Burr Oak, (*Quercus macrocarpa*)	22 "	72 "	165 "
White Oak, (*Quercus alba*)	18 "	60 "	150 "
Persimmon, (*Diospyrus Virginiana*)	5½ "	80 "	115 "
Black Walnut, (*Juglans nigra*)	22 "	74 "	155 "
Honey Locust, (*Gleditschia triacanthos*)	18 "	61 "	129 "
Catalpa, (*Catalpa bignonioides*)	6 "	48 "	101 "
Mulberry, (*Morus rubra*)	10½ "	20 "	62 "
Scarlet Oak, (*Qurcus coccinea*)	20¼ "	94 "	181 "
Sassafras, (*Sassafras officinale*)	7¾ "	75 "	95 "
Bass-Wood, (*Tilia Americana*)	17½ "	50 "	109 "
Bald Cypress, (*Taxodium distychum*)	18¾ "	74 "	146 "
Red Maple, (*Acer rubrum*)	13 "	60 "	108 "
Sycamore. (*Platanus occidentalis*)	33½ "	68 "	176 "
Tulip Tree, (*Liriodendron tulipifera*)	25 "	91 "	190 "
White Ash, (*Fraxinus Americana*)	17½ "	90 "	144 "
Cotton Wood, (*Populus monilifera*)	22 "	75 "	170 "
Sweet Gum, (*Liquidamber styraciflua*)	17 "	80 "	164 "
Black Hickory, (*Carya tomentosa*)	10½ "	55 "	112 "
Sugar Maple, (*Acer saccharinum*)	12½ "	60 "	118 "
Water Oak. (*Quercus palustris*)	12 "	23 "	120 "
Beech, (*Fagus ferruginea*)	11 "	10 "	123 "

to be found a spot from which the best timber has not been culled. Judging from the past, it is safe to say: the time is not distant when there will scarcely be left a sample of those monuments of centuries growth.

Another noteworthy feature of the Wabash valley is, the readiness with which foreign plants make their way to fields and woods and become apparently perfectly naturalized.

The following is a list of plants that have become naturalized and are common, but which are usually considered as adventive in text-books:

Lychnis Githago.
Abutilon Avicennæ.
Nepeta Cataria.
Heliophytum Indicum.
Nicandra physaloides.
Datura stramonium.
Amarantus paniculatus.
Salix alba, var. *vitellina.*
Dactyloctenium Ægyptiacum.
Setaria glauca.
Malva sylvestris.
Trifolium pratense?
Nepeta Glechoma.
Ipomœa Nil.
Lycium vulgare.
Datura tatula.
Cannabis sativa.
Pardanthus Chinensis.
Bromus secalinus?.

Not only is the flora constantly changing by the addition of foreign species, but as civilization advances many of the indigenous plants will have to be stricken from the Flora of the Lower Wabash, as the red man, buffalo, bear, panther, elk, deer and paroquet have been from the fauna, and noted with the things that have passed away. Prominently among them are: Small White Lady's Slipper (*Cypripedium candidum*), Smaller Yellow Lady's Slipper (*Cypripedium parviflorum*), Star-Grass (*Aletris farinosa*), Wild Orange-red Lily (*Lilium Philadelphicum*), Turk's-cap Lily (*Lilium superbum*), Squill (*Scilla Fraseri*), Prickly Pear (*Opuntia Rafinesquii*), Smooth Lungwort (*Mertensia Virginica*). Others will be noticed in their proper places in the catalogue. However, the most striking changes of the flora are those that have been, and are still being wrought on our prairies. Here for many years the numerous perennial grasses, sedges and compositæ, aided by the autumnal prairie fires, held entire sway over such plants as do not annually die down to the root. In proportion as

civilization advanced, prairies were converted into fields, the outlying portions of good grass were mown in summer for hay; and thus in a few seasons the annual visitations of fire suppressed. As a result, in a few years a thick growth of young trees sprung up. And to-day we have, instead of the waving sea of grass, a luxuriant young forest of valuable timber. There are at present more acres of timbered land in some counties of the lower Wabash valley than there were fifty years ago; notwithstanding there have been annually hundreds of acres of forest land cleared and converted into farms. I have conversed with many of the older and more observing citizens on this subject, and find this the uniform opinion among them.

CATALOGUE.

ORDER 1. RANUNCULACEÆ. CROWFOOT FAMILY.

Genus 1. **CLEMATIS**, L. Virgin's Bower.

1. **C. Pitcheri**, Torr. & Gray.
   Bottom lands, scarce. June, Aug.
2. **C. Virginiana**. L. Common Virgin's Bower.
   Rich loose soil and thickets, scarce. July, Sept.

Genus 2. **ANEMONE**, L. Wind-Flower.

1. **A. Virginiana**, L. Virginian Anemone.
   Woods and fields, not rare. May, July.
2. **A. Pennsylvanica**, L. Pennsylvanian Anemone.
   Shaded woods, rare.
3. **A. nemorosa**, L. Wind-Flower. Wood Anemone.
   Open woods, common. April, June.

Genus 3. **HEPATICA**, Dill. Silver-Leaf.

1. **H. acutiloba**, D. C. Sharp-lobed Hepatica.
   Rocky or shaded hillsides, common. March, April.

Genus 4. **THALICTRUM**, Tourn. Meadow Rue.

1. **T. anemonoides**, Michx. Rue Anemone.
   Open rich woods, rare. March, April.
2. **T. dioicum**, L. Early Meadow Rue.
   Open woods, common. March, May.
3. **T. purpurascens**, Purple Meadow Rue.
   Thickets and rich grounds, common. May, July.

Genus 5. **RANUNCULUS**, L. Crowfoot. Butter-Cup.

1. **R. aquatilis**, L. var. **trichophillus**, Chaix. Common White Water Crowfoot.
   Ponds, rare. May, Aug.
2. **R. multifidus**, Pursh. Yellow Water Crowfoot.
   Ponds, not rare. May, July.
3. **R. abortious**, L. Small Flowered Crowfoot.
   Moist rich ground, common. April, July.
4. **R. abortious**, L. var. **micranthus**, Gray.
   Hillsides, rare. April, May.
5. **R. recurvatus**, Poir, Hooked Crowfoot.
   Prairies and fields, common. April, May.
6. **R. fascicularis**, Muhl. Early Crowfoot.
   Hilly woods and fields, not rare. March, May.
7. **R. repens**, L. Creeping Crowfoot.
   Low wet places about streams, abundant. April, July.

Genus 6. **MYOSURUS**, Dill. Mouse Tail.

1. **M. minimus**, L.
   Bottom lands, rare, April.

Genus 7. **ISOPYRUM**, L.

1. **I. biternatum**, Torr. & Gray. False Rue Anemone.
   Open woods, rare. April, May.

Genus 8. **AQUILEGIA.** Tourn. Columbine.

1. **A. Canadensis**, L. Wild Columbine.
   Rocky hillsides, not rare. April, July.
2. **A, vulgaris**, L. Garden Columbine.
   Escaped from gardens to fields. June, Aug. Adv. from Eu.

Genus 9. **DELPHINIUM**, Tourn. Larkspur.

1. **D. tricorne**, Michx. Dwarf Larkspur.
   Rich woods, common. April, May. Flowers, deep purplish blue.
2. **D. consolida**, L. Garden Larkspur,
   Escaped from gardens to fields and roadsides. June, Aug. Adv. from Eu.

Genus 10. **HYDRASTIS**, L. Orange Root. Yellow Puccoon.

1. **H. Canadensis**, L. Ground Raspberry. Turmeric Root.
   Hilly woods, becoming rare. May, June.

Genus 11. **ACTÆA**, L. Baneberry.

1. **A. alba**, Begel. White Baneberry.
   Rich shaded woods, rare. May, June. Variable.

Genus 12. **CIMICIFUGA**, L. Bugbane.

1. **C. racemosa**, Ell. Black Snakeroot, Black Cohosh, Rattle Root, Squaw Root.
   Rich sandy woods, very rare. May, June. Once common, now almost extinct.

Genus 13. **ADONIS**, L. Pheasant's Eye.

1. **A autumnalis**, L.
   Escaped from gardens to fields and roadsides. Adv from Eu.

Genus 14. **NIGELLA**, L. Fennel Flower.

1. **N. Damascena**, L. Ragged Lady. Devil-in-a-bush.
   Escaped from gardens to roadsides and fields. Adv. from Eu.

ORDER 2. MAGNOLIACEÆ. MAGNOLIA FAMILY.

Genus 1. **LIRIODENDRON**, L. Tulip Tree.

1. **L. tulipifera**, L. White, Blue or Yellow Poplor. White Wood.
   Rich hilly soil, common. May, June.

ORDER 3. ANONACEÆ. CUSTARD-APPLE FAMILY.

Genus 1. **ASIMINA**, Adans. North American Pawpaw.

1. **A. triloba**, Dunal. Common Pawpaw.
   Rich woods, common. April, May.

ORDER 4. MENISPERMACEÆ. MOONSEED FAMILY.

Genus 1. **COCCULUS**, D. C. Cocculus.

1. **C. Carolinus**, D. C.
   Rich sandy soil in river bottoms, common. June, Aug.

Genus 2. **MENISPERMUM**, L. Moonseed.

1. **M. Canadense**, L. Canadian Moonseed. Yellow Parilla Vine. Maple Sarsaparilla.
   Rich alluvial soil, common. June, July.

ORDER 5. BERBERIDACEÆ. BARBERRY FAMILY,

Genus 1. **CAULOPHYLLUM**, Michx. Blue Cohosh.

1. **C. thalictroides**, Michx. Pappoose Root.
   Rich shaded woods, rare.

Genus 2. **PODOPHYLLUM**, L. May-Apple. Mandrake.

1. **P. peltatum**, L. Wild Lemon. Raccoon Berry. Wild Mandrake.
   Rich ground, very common. April, May.

ORDER 6. NYMPHÆACEÆ. WATER-LILY FAMILY.

Genus 1. **BRASENIA,** Schreber. Water Shield.

1. **B. peltata,** Pursh.
   Deep ponds, not rare.

Genus 2. **CABOMBA,** Ablet.

1. **C. Caroliniana,** Gray.
   Deeper ponds, common. May, Sept.

Genus 3. **NELUMBIUM,** Juss. Nelumbo. Sacred Bean.

1. **N. luteum,** Willd. Yellow Nelumbo. Water or Pond Chinquepin. Yonkiepin.
   Ponds, common. June, Sept,

Genus 4. **NYMPHÆA,** Tourn. Water Nymph. Water Lily.

1. **N. odorata,** Ait. Sweet-Scented Water Lily. White Pond Lily.
   Ponds and sluggish streams, common. June, Oct.

Genus 5. **NUPHAR,** Smith. Yellow Pond Lily. Spatter Dock.

1, **N. advena,** Ait. Common Yellow Pond Lily.
   Muddy stagnant water, common. May, Oct.
2. **N. sagittifolia,** Pursh.
   Deeper ponds, rare. Aug.

ORDER 7. PAPAVERACEÆ. POPPYFAMILY.

Genus 1: **ARGEMONE,** L. Prickly Poppy,

1. **A. Mexicana,** L. Mexican Prickley Poppy.
   Escaped from flower garden. June, Nov. Adv. from Trop. Amer.

Genus 2. **SANGUINARIA.** Dill. Blood Root.

1. **S. Canadensis,** L. Red Puccoon.
   Rich hilly woods, abundant. March, April.

ORBER 8. FUMARIACEÆ. FUMITORY FAMILY.

Genus 1. **DICENTRA,** Bork. Dutchman's Breeches.

1. **D. Cucullaria,** D. C. Dutchman's Breeches.
   Steep hillsides, not rare. March, April.

Genus 2. **CORYDALIS,** Vent.

1. **C. flavula,** Raf. Yellow Corydalis.
   Rich shaded woods, rare.

ORDER 9. CRUCIFERÆ. MUSRARD FAMILY.

Genus 1. **NASTURTIUM**, R. Br. Water Cress.

1. **N. sessiliflorum**, Nutt.
   Wet places, not rare. April, July.
2. **N. palustre**, D. C. Marsh Cress.
   Wet places, common. May. Aug.
3. **N. lacustre**, Gray. Lake Cress.
   Ponds and slow waters, common. June, Sept.
4. **N. armoracia**, Frise. Horse Radish.
   Moist grounds about farms. Escaped from gardens. June, July. Adv. from Eu.

Genus 2. **DENTARIA**, L. Toothwort. Pepper Root.

1. **D. laciniata**, Muhl.
   Moist rich soil, abandant. March, May. Exceedingly variable, often answering better to the description of **D. multifida**, Muhl. or **D. heterophylla**, Nutt.

Genus 3. **CARDAMINE**, L. Bitter Cress.

1. **C. rhomboidea.** D. C. Spring Cress.
   Low wet places, common. March, May.
2. **C. hirsuta**, L. Small Bitter Cress.
   Moist grounds, common. April, June.

Genus 4. **ARABIS**, L. Rock Cress.

1. **A. lævigata**, D. C.
   Rocky bluffs, not common. June, July.
2. **A. hesperidoides**, Gray.
   Low rich woods, abundant. April, July.

Genus 5. **SISYMBRIUM**, L. Hedge Mustard.

1. **S. officinalis**, Scop. Hedge Mustard.
   Fields and dwellings, common. April, Dec. Nat. from Eu.

Genus 6. **BRASSICA.** Gray.

1. **B. nigra**, Gray. Black Mustard.
   About dwellings and fields, common. June, Aug. Nat. from Eu.

Genus 7. **DRABA**, L. Whitlow Grass.

1. **D. brachycarpa**, Nutt.
   Dry sandy soil, common. March, April.

Genus 8, **CAPSELLA**, Vent. Shepherd's Purse.

1. **C. Bursa-pastoris**, Mœnch.
   About dwellings and fields, abundant. April, Dec. Nat. from Eu.

Genus 9. **LEPIDIUM**, L. Pepperwort. Peppergrass.

1. **L. Virginicum**, L. Wild Peppergrass. Tongue-Grass.
   Cultivated grounds, common. May, Sept.

ORDER 10. CAPPARIDACEÆ. CAPER FAMILY.

Genus 1. POLANISIA, Raf.

1. **P. graveolens**, Raf.
   Sandy and gravelly shores, not rare. June, Sept.

Genus 2. CLEOME, L.

1. **C. pungens**, L. Spider Flower.
   Escaped from gardens. June, Oct. Adv. from W. India.

ORDER 11. VIOLACEÆ. VIOLET FAMILY.

Genus 1. VIOLA, L. Violet. Heart's-ease.

1. **V. primulæfolia**, D. Primrose-leaved Violet.
   Moist soil, rare. April, May.
2. **V. cucullata**. Ait. Common Blue Violet.
   Woods and hillsides, abundant. March, July.
3. **V, cucullata** var. **palmata**, Gray. Hand-leaf Violet.
   Open woods, not rare. March, June.
4. **V. delphinifolia**, Nutt. Larkspur-leaved Violet.
   Prairie, rare. May.
5. **V. striata**, Ait. Pale Violet.
   Low grounds, scarce.
6. **V. pubescens**, Ait. Downy Yellow Violet.
   Rich moist wood, rare. April, June.
7. **V. tricolor**, L. Pansy. Heart's-ease. Johnny-jump-up.
   About old fields and dwellings, rare. March, July. Escaped from gardens. Hardly naturalized.
8. **V. tricolor** var. **arvensis**, Gray.
   Fields and open rich woods, not rare. March, Sept. Nat. from Eu.

ORDER 12. HYPERIACEÆ. ST. JOHNS-WORT FAMILY.

Genus 1. HYPERICUM, L. St. John's-wort.

1. **H. prolificum**, L. Shrubby St. John's-wort.
   Moist places, rare. June, Aug.
2. **H. adpressum**, Barton.
   Moist soil, scarce.
3. **H· perforatum**, L. Common St. John's-wort.
   Moist fields, common. June, Sept. Nat. from Eu.
4. **H. corymbosum**, Muhl.
   Damp grounds, common. June, Sept.
5. **H. multilum**, L. Dwarf St. John's-wort.
   Wet shaded places, common. June, Sept.
6. **H. Drummondii**, Torr. & Gray.
   Dry hard soil, rare.
7. **H. Sarothra**, Michx.
   Sterile sandy soil, rare.

Genus 2. **ELODES**, Adams. Marsh St. John's-wort.

1. **E. Virginica**, Nutt.
   In a cypress swamp. Sept.

ORDER 13. ELATINACEÆ. WATER-WORT FAMILY.

Genus 1. **ELATINE**. Water-wort.

1. **E. Americana**, Arnott.
   Moist places, not rare. May, June.

ORDER 14. CARYOPHYLLACEÆ. PINK FAMILY.

Genus 1. **SAPONARIA**, L. Soapwort.

1. **S. officinalis**, L. Common Soapwort. Bouncing Bet.
   Streets and readsides. June, Sept. Escaped from gardens. Adv. from Eu.

Genus 2. **SILENE**, L. Catchfly. Campion.

1. **S. stellata**, Ait. Starry Campion.
   Woods and fields in sandy places, not rare. June, Aug.
2. **S. Armeria**, L. Sweet-William Catchfly.
   Escaped from gardens. June, Sept. Adv. from Eu.
3. **S. antirrhina**, L. Sleepy Catchfly.
   In poor grounds among the cereals, common. May, Sept.

Genus 3. **LYCHNIS**, Tourn. Lychnis. Cockle.

1. **L, Githago**, Lam. Corn Cockle.
   In fields among the cereals, too common. June, July. Nat. from Eu.

Genus 4. **STELLARIA**, L. Chickweed. Starwort.

1. **S. longifolia**, Muhl. Long-leaved Stitchwort.
   About fields, not rare. May, June.

Genus 5. **CERASTIUM**, L. Mouse-ear Chickweed.

1. **C. viscosum**, L. Larger Mouse-ear Chickweed.
   About fields, common. April, July. Nat. from Eu.
2. **C. nutans**, Raf.
   Fields and pastures, common. April, June.
3. **C. oblongifolium**, Torr.
   Dry prairie soil, rare.

Genus 6. **SAGINA**, L. Pearlwort.

1. **S. apetala**, L.
   Dry woods, rare, June.

Genus 7. **ANYCHIA**, Michx. Forked Chickweed.

1. **A. dichotoma**, Michx.
   Moist rich woods, not rare. June, July.

Genus 8. **MOLLUGO**, L. Indian Chickweed.

1. **M. verticillata**, L. Carpet Weed.
Dry sandy places, common. June, Sept.

ORDER 15. PORTULACACÆ. Purslane Family.

Genus 1. **PORTULACA**, Tourn. Purslane.

1. **P. oleracea**, L. Common Purslane. Hog Parsley.
In cultivated grounds, too common. May, Aug. Nat. from Eu.
2. **P. grandiflora**, Hook. Flowering Moss. Flowering Purslane.
Escaped from flower gardens to streets, &c. June, Oct. Adv. from S. A.

Genus 2. **CLAYTONIA**, L. Spring Beauty.

1. **C. Virginica**, L. May or Turkey Pea.
Woods ond fields, abundant. April, May. Variable in color of flower and width of leaf.

ORDER 16. MALOACEÆ. Mallow Family.

Genus 1. **MALOA**, L. Mallow.

1. **M. rotundifolia**, L. Common Mallow.
Idle places about dwellings, common. June, Oct. Nat. from Eu.
2. **M. sylvestris**, L. High Mallow.
About dwellings and roadsides, common. July, Sept. Nat. from Eu.

Genus 2. **SIDA**. L.

1. **S. spinosa**, L.
Fields and idle grounds, abundant. May, Aug. Nat. from Trop. Amer.

Genus 3. **ABUTILON**, Tourn. Indian Mallow.

1. **A. Avicennæ**, Gærtn. Velvet Leaf. Butter Mark.
Waste places, common. July, Sept. Nat. from India.

Genus 4. **HIBISCUS**, L. Rose Mallow.

1. **H. grandiflorus**, Michx. Prairie Hollyhock.
Moist prairies, common. Aug., Sept.
2. **H. militaris**, Cav. Halberd-leaved Rose Mallow.
Banks of streams, not rare. June, Aug.
3. **H. Trionum**, L. Bladder Ketmia. Flower-of-an-hour.
Escaped from flower gardens. May, Sept. Adv. from Eu.

Order 17. TILIACEÆ. Linden Family.

Genus 1. **TILIA**, L. Linden. Basswood.

1. **T. Americana,** L. Basswood. Lin-Tree. Whittle-wood.
   Gravelly soil, common.
2. **T. heterophylla,** Vent. White Basswood.
   Have seen one tree near the mouth of White river.

Order 18. LINACEÆ. Flax Family.

Genus 1. **LINUM**, L. Flax.

1. **L. Virginianum,** L.
   Clayey grounds, common. June, Aug.
2. **L. usitatissimum,** L. Common Flax.
   Escaped from cultivation. rare. Nativity not certainly known.

Order 19. GERANIACEÆ. Geranium Family.

Genus 1. **GERANIUM**, L. Cranesbill.

1. **G. maculatum,** L Spotted Geranium. Wild Cranesbill.
   Woods and about fields, common. April, July.
2. **G. Carolinianum,** L. Carolina Cranesbill.

Genus 2. **ERODIUM**, L'Her Stork's Bill.

1. **E. cicutarium,** L'Her.
   Escaped from gardens, very rare. Adv. from Eu.

Genus 3. **IMPATIENS,** L. Balsam. Jewel-weed.

1. **I. pallida,** Nutt. Pale Touch-me-not.
   Moist shaded places, common. June, Sept.
2. **I. fulva,** Nutt. Spotted Touch-me-not.
   Moist rich soil, abundant. June, Sept. This and **I. pallida** are often found growing in the same patch.

Genus 4. **OXALIS**, L. Wood-Sorrel.

1. **O. violacea,** L. Violet Wood-Sorrel.
   Open woods and fields, common. April, June.
2. **O. stricta,** L. Yellow Wood-Sorrel.
   Rich soil and fence-rows, common. April, Sept.

Order 20. RUTACEÆ. Rue Family.

Genus 1. **ZANTHOXYLUM**, Colden. Prickly Ash.

1. **Z. Americanum,** Mill. Northern Prickly Ash.
   Low rich woods, rapidly becoming rare.

Genus 2. **PTELEA**, L. Shrubby Trefoil.

1. **P. trifoliata,** L. Hop-Tree. Wing-Seed. Wafer-Ash.
   Shaded sandy river banks, not rare. May.

ORDER 21. ANACARDIACEÆ. Cashew Family.

Genus 1. **RHUS**, L. Sumach.

1. **R. typhina**, L. Staghorn Sumach.
   Sandy hillsides, rare.
2. **R. glabra**, L. Smooth Sumach.
   Barren Sandy soil, common. May, June.
3. **R. Toxicodendron**, L. Poison Oak. Poison Ivy. Poison Vine.
   Common. Varies from a vine that ascends trees to the hight of 150 feet, to a small bush 3–6 feet high.

ORDER 22. VITACEÆ. Vine Family.

Genus 1. **VITIS**, Tourn. Grape.

1. **V. Labrusca**, L. Northern Fox-Grape.
   Upland woods, rare. May. Usually but wrongly called Summer Grape.
2. **V. æstivalis**, Michx. Summer Grape.
   Thickets in rich grounds, common. April, May.
3. **V. cordifolia**, Michx. Winter or Frost Grape.
   Bottom lands, common. May.
4. **V. riparia**, Michx.
   River bottoms, not rare. April, May.
5. **V. indivisi**, Willd.
   Moist woods and thickets, frequent. May, June.

Genus 2. **AMPELOPSIS**, Michx. Virginia Creeper.

2. **A. quinquefolia**, Michx. Five-Leaves. False-Grape. Wild Wood-vine. American Ivy. Woodbine, and erroneously Poison Vine.
   Rich woods and fields, abundant. June, July.

ORDER 23. RHAMNACEÆ. Buckthorn Family.

Genus 1. **CEANOTHUS**, L. New Jersey Tea. Red-Root.

1. **C. Americanus**, L. New Jersey Tea. Wild Snow-Ball.
   Dry sandy hillsides, not common. June, July.

ORDER 24. CELASTRACEÆ. Staff-Tree Family.

Genus 1. **CELASTRUS**, L. Staff-Tree. Shrubby Bitter-Sweet.

1. **C. scandens**. Wax-Work. Climbing Bitter-Sweet.
   Rich woods, not rare.

Genus 2. **EUONYMUS**, Tourn. Spindle Tree.

1. **E. atropurpureus**, Jacq. Burning Bush. Waahoo. Indian Arrow-Wood.
   Rich alluvial soil, common. May, June.
2. **E. Americanus**, L. Strawberry Bush.
   River banks, rare.

ORDER 25. SAPINDACEÆ. Soapberry Family.

Genus 1. **STAPHYLEA**, L. Bladder Nut.

1. **S. trifolia**, L. American Bladder Nut.
   Near the borders of Small streams, scarce. May.

Genus 2. **ÆSCULUS**, L. Horse Chestnut. Buckeye.

1. **Æ. glabra**, Willd, Fetid or Ohio Buckeye.
   River bottoms, rare. April, May.

Genus 3. **ACER**, Tourn. Maple.

1. **A. saccharinum**, Wang. Sugar or Rock Maple.
   Upland woods and hillsides, common. March, April.
2. **A. dasycarpum**, Ehrhart. White or Silver Maple.
   Banks of streams, rare. March, April.
3. **A. rubrum**, L. Red or Swamp Maple.
   Low wet places, common. Feb., March.

Genus 4. **NEGUNDO**, Mœnch. Ash-leaved Maple.

1. **N. aceroides**, Mœnch. Box Elder.
   Moist banks, not common. March, April.

Genus 5. **CARDIOSPERMUM**, L. Heart Seed.

1. **C. Haliacabum**, L. Balloon Vine.
   Escaped from gardens. Adv. from Missouri, &c.

ORDER 26. POLYGALACEÆ. MILKWORT FAMILY.

Genus 1. **POLYGALA**, Tourn. Milkwort.

1. **P. sanguinea**, L.
   Gravelly or clayey soil, rare. July, Oct.
2. **P. ambigua**, Nutt.
   Dry prairies, rare. July, Sept,
3. **P. Senega**, L. Seneca Snakeroot.
   Rocky soil, rare. April, June.

ORDER 27. LEGUMINOSÆ. PULSE FAMILY.

Genus 1. **CROTALARIA**, L. Rattle-Box.

1. **C. sagittalis**, L.
   Sterile prairie soil, rare. July, Aug.

Genus 2. **TRIFOLIUM**, L. Clover. Tre-foil.

1. **T. pratense**, L. Red Clover.
   About fields and open woods, common. May, Dec. Nat. from Eu.
2. **T. reflexum**, L. Buffalo Clover.
   Sandy grounds, rare. May.
3. **T. repens**, L. White Clover.
   Fields, copses and pastures, too common. April, Sept.

Genus 3. **MELILOTUS,** Tourn. Melilot. Sweet Clover.

1. **M. alba,** Lam. White Melilot.
   Escaped from gardens. July, Sept. Adv. from Eu.

Genus 4. **PSORALEA,** L.

1. **P. Onobrychis.** Nutt.
   Thickets and fence rows. June, Aug.

Genus 5. **PETALOSTEMON,** Michx. Prairie Clover.

1. **P. violacens,** Michx.
   Dry places and prairies, rare.

Genus 6. **AMORPHA,** L. False Indigo.

1. **A. fructicosa,** L. False Indigo.
   Wet places, common. May, June. Leaves exhale when bruised, a strong unpleasant odor.

Genus 7. **ROBINIA,** L. Locust Tree.

1. **R. Pseudacacia,** Black Locust. Common Locust or False Acacia.
   Fscaped to improved grounds and borders of woods. May. Nat. from E. U. S.

Genus 8. **WISTARIA,** Nutt.

1. **W. frutescens,** D. C. Wild Wistaria.
   Alluvial sandy soil, rare.

Genus 9. **ASTRAGALUS,** L. Milk Vetch.

1. **A. Canadensis,** L.
   Banks of streams, common. July, Aug.

Genus 10. **DESMODIUM,** D. C. Tick Trefoil.

1. **D. nudiflorum,** D. C.
   Dry woods, not common. July, Aug.
2. **D. acuminatum,** D. C.
   Woods and fields, common. July, Aug.
3. **D. pauciflorum,** D. C.
   Open woods, rare, June, Aug.
4. **D. cuspidatum,** Torr. & Gray.
   Dry clayey grounds, rare. Aug., Sept.
5. **D. Dillenii,** Darlingt.
   Prairies and open woods, not rare. July, Aug.
6. **D. paniculatum,** D. C.
   Copses, rare.
7. **D. sessilifolium,** Torr. & Gray.
   Clayey soil, not rare. July, Sept.
8. **D, rigidum,** D. C,
   Dry open woods, common.
9. **D. ciliare,** D. C.
   Dry hillsides, rare.
10. **D. Marilandicum,** Boott.
   Open hilly woods, rare.

Genus 11. **LESPEDEZA,** Mich. Bush Clover.

1. **L. violacea,** Pers. var. **angustifolia,** Gray.
   Dry open soil, not common. July, Sept.
2. **L. hirta,** Ell.
   Dry clayey soil, common.
3. **L. capitata,** Michx.
   Dry soil, not rare.

Genus 12. **STYLOSANTHES.** Swartz. Pencil Flower.

1. **S. elatior,** Swartz.
   Dry soil, rare. July, Nov.

Genus 13. **LATHYRUS,** L. Netchling. Everlasting Pea.

1. **L. palustris,** L. Marsh Vetchling.
   Wet thickets, rare.

Genus 14. **APIOS,** Boorhaave. Wild Bean.

1. **A. tuberosa,** Mœnch. Ground Nut.
   Miry places and thickets, common. July, Sept.

Genus 15. **PHASEOLUS,** L. Kidney Bean.

1. **P. perennis,** Walt. Wild Bean.
   Woods, common. June, Aug.
2. **P. diversifolius,** Pers.
   Clayey or sandy open prairies, rare. Aug., Sept.
3. **P. helvolus,** L.
   Dry clayey soil and prairies, common. July, Sept.
4. **P. pauciflorus,** Benth.
   Banks of streams, rare.

Genus 16. **AMPHICARPÆA,** Ell. Hog Peanut.

1. **A. monoica,** Nutt.
   Rich woodlands, common. July, Sept.

Genus 17. **BAPTISIA,** Vent. False Indigo.

1. **B. leucantha,** Torr. and Gray.
   Moist prairies, common. June, Sept.

Genus 18. **CERCIS,** L. Judas Tree.

1. **C. Canadensis,** L. Red-Bud Tree.
   In moist localities, but not abundant. March, May.

Genus 19. **CASSIA,** L. Senna.

1. **C. Marilandica,** L. Wild Senna.
   Moist rich grounds, common. June, Sept.
2. **C. Chamæcrista,** L. Partridge Pea.
   Clayey soil, common. July, Aug.
3. **C. nictitans,** L. Wild Sensitive-Plant.
   Sterile places, not common. Aug., Sept.

Genus 20. **GYMNOCLADUS,** Lam. Kentucky Coffee-tree.

1. **G. Canadensis,** Lam. Coffee-tree.
   River bottoms, not common.

Genus 21. **GLEDITSCHIA,** L. Honey Locust.

1. **G. triacanthos,** L. Three-thorned Acacia. Honey Locust.
   Rich grounds, not abundant.
2. **G. monosperma,** Walt. Water Locust.
   Cypress swamps, not common.

ORDER 28. ROSACEÆ. Rose Family.

Genus 1. **PRUNUS,** Tourn. Plum. Cherry.

1. **P. Americana,** Marshall. Wild Yellow or Red Plum.
   Scattered through the woods, but nowhere abundant. Apr.
2. **P. serotina,** Ehrhart. Wild Black Cherry. Wild Cherry.
   Woods, not abundant, and rapidly becoming rare. May.

Genus 2. **SPIRÆA,** L. Meadow-Sweet.

1. **S. opulifolia,** L. Nine Barks.
   Rocky bluffs, rare.
2. **S. salicifolia,** L. Common Meadow-Sweet.
   Wet grounds, very rare except in cultivation. May, Oct.
3. **S. aruncus,** L. Goat's Beard.
   Steep shaded banks, not rare. July, Sept.

Genus 3. **GILLENIA,** Mœnch. Indian Physic.

1. **G. trifoliata,** Mœnch. Bowman's Root.
   Woods, rare. June, July.

Genus 4. **AGRIMONIA,** Tourn.

1. **A. Eupatoria,** L. Common Agrimony
   Open woods, common. July, Sept.
2. **A. parviflora,** Ait. Small-flowered Agrimony.
   Rich grounds, not rare. Aug.

Genus 5. **GEUM,** L. Avens.

1. **G. Virginicum,** L.
   Low grounds, common. May, Aug.
2. **G. vernum,** Torr. and Gray.
   Borders of woods and glades, not common. March, June.

Genus 6. **POTENTILLA,** L. Cinque-foil. Five-finger.

1. **P. Canadensis,** L. Common Cinque-foil, or Five-finger.
   About fields and open woods, abundant. April, July.

Genus 7. **FRAGARIA,** Tourn. Strawberry.

1. **F. Virginiana,** var. **Illinoensis,** Gray. Wild Strawberry.
   Rich sandy grounds, not rare. April, May.

Genus 8. **RUBUS,** Tourn. Bramble.

1. **R. strigosus,** Michx. Wild Red Raspberry.
   Thickets, rare.
2. **R. occidentalis,** L. Black Raspberry. Thimbleberry.
   Thickets and fence rows, common. May.
3. **R, villosus,** Ait. Common or High Blackberry.
   Fence rows and thickets, too abundant. May, June.
4. **R. villosus** var. **humifusus,** Gray. Trailing Blackberry.
   Along fence rows and in fields, not rare.
5. **R. Canadensis,** L. Low Blackberry. Dewberry.
   Fields and woods, common. April, May.

Genus 9. **ROSA,** Tourn. Rose.

1. **R. setigera,** Michx. Climbing or Prairie Rose.
   Thickets and prairies, common. June, Aug. Not fragrant.
2. **R. Carolina,** L. Swamp Rose.
   Low wet grounds, common. May, Sept. Very fragrant.
2. **R. lucida,** Ehrhart. Dwarf Wild Rose.
   Dry sandy soil, rare. May, Sept.
4. **R. rubiginosa;** L. Sweet Briar.
   Escaped from cultivation. Nat. from Eu.

Genus 10. **CRATÆGUS.** L. Hawthorn. White Thorn.

1. **C. coccinea,** L. Scarlet-fruited Thorn.
   Open upland woods, not rare. April, May.
2. **C. tomentosa,** L. Black or Pea Thorn.
   Thickets, rare. March, April.
3. **C. tomentosa** var. **punctata,** Gray.
   Rich alluvial soil, common. March, May.
4. **C. tomentosa,** var. **mollis,** Gray.
   Moist woods, rare. April, May.
5. **C. Crus-galli,** L. Cockspur Thorn.
   Low moist thickets, common. March, May.

Genus 11. **PYRUS,** L. Pear, Apple.

1. **P. coronaria,** L. American Crab-Apple.
   Open woods and glades, not rare. April, May.
2. **P. angustifolia,** Ait. Narrow-leaved Crab-Apple.
   Rich woods, April, May. Tree usually taller than **P. coronaria.**

ORDER 29. SAXIFRAGACEÆ. SAXIFRAGE FAMILY.

Genus 1. **HYDRANGEA,** Gronov.

1. **H. arborescens,** L. Wild Hydrangea. Seven Barks.
   Steep bluffs, not abundant. June, Sept.

Genus 2. **HEUCHERA,** L. Alum-Root.

1. **H. Americana,** L. Common Alum Root.
   Sandy soil and gravelly bluffs, not rare. May, Aug.

ORDER 30. CRASSULACEÆ. ORPINE FAMILY.

Genus 1. **PENTHORUM**, Gronov. Ditch Stone-Crop.

1. **P. sedoides**, L.
   Wet places, common. June, Oct.

Genus 2. **SEDUM**, Tourn. Stone-Crop. Orpine.

1. **S. acre**, L. Mossy Stone-Crop.
   Sparingly escaped from gardens. Adv. from Eu.
2. **S. ternatum**, Michx.
   Rocky bluffs, rare. May, July.

ORDER 31. HAMAMELACEÆ. WITCH-HAZEL FAMILY.

Genus 1. **LIQUIDAMBAR**, L. Sweet Gum Tree.

1. **L. styraciflua**, L. Sweet-gum. Bilsted.
   Bottom lands and alluvial soil, common. May.

ORDER 32. HALORAGEÆ. WATER-MILFOIL FAMILY.

Genus 1. **MYRIOPHYLLUM**, Vaill. Water Milfoil.

1. **M. ambiguum**, var. **capillaceum**, Gray.
   Ponds, not rare.

Genus 2. **PROSERPINACEA**, L. Mermaid Weed.

1. **P. palustris**, L.
   Moist bottom lands, not rare. Aug., Oct.

Genus 3. **HIPPURIS**, L. Mare's Tail.

1. **H. vulgaris**, L.
   Pond and streams, rare.

ORDER 33. ONAGRACEÆ. EVENING PRIMROSE FAMILY.

Genus 1. **CIRCÆA**, Tourn. Enchanter's Nightshade.

1. **C. Lutetiana**, L.
   Rich shaded woods, common. July, Aug.

Genus 2. **GAURA**, L.

1. **G. biennis**, L.
   Prairies and fields, common. Aug., Sept.

Genus 3. **EPILOBIUM**. L. Willow-Herb.

1. **E. coloratum**, Muhl.
   Wet places, rare. July, Sept.

Genus 4. **ŒNOTHERA**, L. Evening Primrose.

1. **Œ. biennis**, L. Common Evening Primrose.
   Fields and borders of woods, abundant. June, Sept.
2. **Œ. biennis**, var. **muricata**, Gray.
   About fields, &c., common.
3. **Œ. fruticosa**, L. Sundrops.
   Low rich grounds, not common. July, Aug.

Genus 5. **LUDWIGIA**, L. False Loosestrife.

1. **L. alternifolia**, L. Seed-box.
   Wet places, common. July, Sept.
2. **L. polycarpa**, Short & Peter.
   Moist places, common. July, Oct.
3. **L. palustris**, Ell. Water Purslane.
   Muddy and wet places, not common. July, Sept.

ORDER 34. LYTHRACEÆ. LOOSESTRIFE FAMILY.

Genus 1. **AMMANNIA**, Houston.

1. **A. latifolia**, L.
   Borders of stagnant water, not rare. Aug., Nov.

Genus 2. **LYTHRUM**, L. Loosestrife.

1. **L. alatum**. Pursh.
   Wet places in fields and prairies. June, Sept.

Genus 3. **NESÆA**, Commerson, Juss.

1. **N. verticillata**, H. B. K. Swamp Loosestrife.
   Swampy places, rare. July, Sept.

Genus 4. **CUPHEA**, Jacq.

1. **C. viscosissima**, Jacq. Clammy Cuphea.
   Roadsides and dry open grounds, abundant. June, Sept.

ORDER 35. CACTACEÆ. CACTUS FAMILY.

Genus 1. **OPUNTIA**, Tourn.

1. **O. vulgaris**, Mill. Prickley Pear.
   Escaped from cultivation to old stumps and rocky places. June, Aug. Adv. from Eastern and Southern U. S.
2. **O. Rafinesquii**, Engelm. Indian or Prairie Fig.
   Once common on our prairies, but very seldom found now, May, Aug.

ORDER 36. **PASSIFLORACEÆ.** PASSION-FLOWER FAMILY.

Genus 1. **PASSIFLORA**, L. Passion Flower.

1. **P. lutea**, L. Wild Passion Flower.
   Thickets and fence rows, rare. July, Sept.
2. **P. incarnata**, L. Garden Passion Flower. Maypops.
   Escaped from cultivation. May, Aug. Adv. from the S. W. S.

ORDER 37. **CUCURBITACEÆ.** GOURD FAMILY.

Genus 1. **SICYOS**, L. One-seeded Star Cucumber.

1. **S. angulatus**, L,
   Alluvial soil and river bottoms, common. July, Sept.

Genus 2. **ECHINOCYSTIS**, Torr. & Gray. Water Balsam Apple.

1. **E. lobata**, Torr. & Gray. Climbing Thorn Apple.
   River banks, rare. July, Sept.

ORDER 38. **UMBELLIFERÆ.** PARSLEY FAMILY.

Genus 1. **SANICULA**, Tourn. Sanicle. Black Snakeroot.

1. **S. Marilandica**, L.
   Rich grounds, not abundant. May.

Genus 2. **ERYNGIUM**, Tourn. Eryngo.

1. **E. Yuccæfolium**, Michx. Rattlesnake Master. Button Snakeroot.
   Dry open grounds and prairies, not rare. July, Sept.

Genus 3. **DAUCUS**, Tourn, Carrot.

1. **D. carota**, L. Common Carrot.
   Escaped from gardens. July, Sept. Adv. from Eu.

Genus 4. **PASTINACA**, Tourn. Parsnip.

1. **P. sativa**, D. Common Parsnip.
   Escaped from gardens to fields. June, July. Adv. from Eu.

Genus 5. **ARCHEMORA**, D. C. Cowbane.

1. **A. rigida**, D. C. Water Cowbane.
   Miry wet places, rare. July, Aug.

Genus 6. **THASPIUM**, Nutt. Meadow Parsnip.

1. **T. aureum**, Nutt. Golden Meadow Parsnip.
   Rich grounds, common. May, June.
2. **T. trifoliatum**, Gray.
   Moist shaded woods, rare. May, June.

Genus 7. **ZIZIA**, D. C.

1. **Z. integerrima**, D. C.
Hilly woods, not common. May, June.

Genus 8. **CICUTA**, L. Water Hemlock.

1. **C. maculata**, L. Spotted Cowbane. Musquash Root. Beaver Poison.
Low wet places, abundant. June, Sept.

Genus 9. **SIUM**, L, Water Parsnip.

1. **S. lineare**, Michx.
Wet places, common. July, Sept.

Genus 10. **CRYPTOTÆNIA**, D. C. Honewort.

1. **C. Canadensis**, D. C.
Sandy grounds and thickets, not rare. June, Sept.

Genus 11. **CHÆROPHYLLUM**. L. Chervil.

1. **C. procumbens**, Lam.
Moist rich woods, not scarce. April, May.

Genus 12. **OSMORRHIZA**, Raf. Sweet Cicely.

1. **O. longistylis**, D. C. Smoother Sweet Cicely.
Rich woods, rare.
2. **O. brevistylis**, D. C. Hairy Sweet Cicely.
Damp thickets, scarce.

Genus 13. **CONIUM**, L. Poison Hemlock.

1. **C. maculatum**, L. Poison Parsley.
Fields, rare. July, Aug. Nat. from Eu.

Genus 14. **EULOPHUS**, Nutt.

1. **E. Americana**, Nutt.
Prairies, rare. June, July.

Genus 15. **ERIGENIA**, Nutt. Harbinger of Spring.

1. **E. bulbosa**, Tourn. Pepper-and-Salt. Daughter of the Early Spring.
Hillsides, not common. March, April.

ORDER 39. ARALIACEÆ. GINSENG FAMILY.

Genus 1. **ARALIA**, Tourn. Ginseng. Wild Sarsaparilla.

1. **A. racemosa**, L. Spikenard. Pettymorrel.
Rich rocky woods, rare. June.
2. **A. nudicaulis**, L. Wild Sarsaparilla. Small Spikenard.
Rocky woods and bluffs, rare. May, June.
3. **A. quinquefolia**, Gray. Ginseng.
Rich hilly woods, once common, but now rarely seen. June July.

ORDER 40. CORNACEÆ. DOGWOOD FAMILY.

Genus 1. **CORNUS,** Tourn. Cornel Dogwood.

1. **C, florida,** L. Flowering Dogwood. Flowering Cornel. Boxwood.
   Woods in most localities, but nowhere abundant. April, May.
2. **C. ceircea,** L. Silky Cornel. Kinnikinnik. Rose Willow, Red Osier. Red Willow.
   Low banks, rare.
3. **C. paniculata,** L'Her. Panicled Cornel. Swamp Dogwood.
   Low wet thickets, common. April, May.

Genus 2. **NYSSA,** L. Tupelo. Pepperidge. Sour Gum-Tree.

1. **N. multiflora,** Wang. Black Gum.
   Hilly woods and river bottoms, not abundant.

ORDER 41. CAPRIFOLIACEÆ. HONEYSUCKLE FAMILY.

Genus 1. **SYMPHORICARPUS,** Dill. Snowberry.

1. **S racemosus,** Michx. Snowberry.
   Escaped from cultivation to fence-rows. Nat. from N. U. S.
2. **S. vulgaris,** Michx. Indian Currant. Coral-Berry. Buck-Berry Bush.
   Sandy ridges in river bottoms. Common. May, June.

Genus 2. **SAMBUCUS,** Tourn. Elder.

1. **S. Canadénsis,** L. Common Elder.
   Fence-rows and thickets, common. May, Jpne.

Genus 3. **VIBURNUM,** L. Arrow-wood. Laurestinus.

1. **V. Lentago.** Sweet Viburnum. Sheep-Berry.
   Dry open woods, scarce.
2. **V prunifolium,** L. Black Haw.
   Near streams and river bottoms, not rare. April, May.
3. **V. dentatum,** L. Arrow-Wood.
   I have seen but one tree. May, June.

ORDER 42. RUBIACEÆ MADDER FAMILY.

Genus 1. **GALIUM,** L. Bedstraw. Cleavers.

1. **G. Aparine,** L. Cleavers. Goose-Grass. Catch-Grass.
   Fields and thickets, not abundant. May, June.
2. **G. trifidum,** L. Small Bedstraw.
   Low damp woods, common.
3. **G. trifidum, var. tinctorum,** Gray.
   Wet places, rare. July, Aug.
4. **G circæzans,** Michx. Wild Liquorice.
   Rich shaded woods, common. June, Oct.

Genus 2. **SPERMACOCE**, L. Button-Weed.

1. **S. glabra**, Michx.
   Rich woods, rare. July, Aug.

Genus 3. **DIODIA**, L. Button-Weed.

1. **D. teres**, Walt.
   Clayey soil in roads and fields, common. July, Sept.

Genus 4. **CEPHALANTHUS**, L. Button-Bush.

1. **C. occidentalis**, L. Pond Dogwood. Globe Flower.
   About ponds, common. June, Sept.

Genus 5. **HOUSTONIA**, L.

1. **H. purpurea**, L. Purple Houstonia.
   Open woods, common. May, Aug.

ORDER 43. VALERIANACEÆ. VALERIAN FAMILY.

Genus 1. **VALERIANA**, Tourn. Valarian.

1. **V. pauciflora**, Michx.
   River bottoms, rare. May, June,

ORDER 44. DIPSACEÆ. TEASEL FAMILY.

Genus 1. **DIPSACUS**, Tourn. Teasel.

1. **D. sylvestris**, Mill. Wild Teasel.
   Borders of fields, rare. June, July. Nat. from Eu.

ORDER 45. COMPOSITAE. COMPOSITE FAMILY.

Genus 1. **VERNONIA**, Screb. Iron-Weed.

1. **V. Noveboracensis**, Willd.
   Moist open places, common. July, Sept.
2. **V. fasciculata**, Michx. Common Iron-Weed.
   Abundant. Aug., Sept.

Genus 2. **ELEPHANTOPUS**, L, Elephant's Foot.

1. **E. Carolinianus**, Willd.
   Dry rich soil and glades, common. July, Aug.

Genus 3. **LIATRIS**, Schreb. Button Snakeroot. Blazing Star.

1. **L. squarrosa**, Willd. Blazing Star.
   Dry soil, rare.
2. **L. cylindracea**, Michx.
   Dry prairies, rare. Aug., Sept.
3. **L. scariosa**, Willd. Gay Feather.
   Dry rocky soil, not common. Aug., Oct.
4. **L. pycnostachya**, Michx. Prairie Gay Feather.
   Moist prairies, rare. July, Sept.

Genus 4. **EUPATORIUM**, Tourn. Thoroughwort. Boneset.

1. **E. purpureum**, L. Joe-Pie Weed. Trumpet Weed, Queen-of-the-Meadow.
   Rich low grounds, common. July, Sept.
2. **E. sessilifolium**, L. Upland Boneset.
   Moist grounds, common. July, Sept.
3. **E. perfoliatum**, L. Thoroughwort. Boneset.
   Low moist grounds, common. Aug.. Oct.
4. **E. serotinum**, Michx.
   Moist grounds and alluvial soil, common. Aug., Sept.
5. **E. ageratoides**, L. White Snake Root.
   Rich hilly woods and open places, abundant. July, Oct. Always pubescent instead of smooth as stated in the text-books. It also possesses a pleasant pungent scent.

Genus 5. **MIKANIA**, Willd. Climbing Hemp Weed.

1. **M. scandens**, L.
   Sandy thickets along streams, rare.

Genus 6. **CONOCLINIUM**, D. C.

1. **C. cœlestinum**, D. C. Mist Flower.
   Open rich woods, Abundant. July, Oct.

Genus 7. **ASTER**, L. Asterwort.

1. **A. patens**, Sit.
   Dry grounds, not common. Aug., Oct.
2. **A. azurens**, Lindl.
   Open woods, not abundant. Aug., Oct.
3. **A. undulatus**. L.
   Dry copses, abundant. Aug, Oct.
4. **A. cordifolius**, L.
   Upland woods, abundant. Aug., Nov.
5. **A. sagittifolius**, Willd.
   Dry soil, common. Aug., Oct.
6. **A. dumosus**, L.
   Woods, rare. Sept., Oct.
7. **A. miser**, L., Ait. Starved Aster.
   Dry clayey soil, common. Aug., Oct.
8. **A. tenuifolius**, L.
   Rich soil, not common. Sept., Oct.
9. **A. carneus**, Nees.
   Moist soil, common. Sept.
10. **A. puniceus**, L. Red-Stalked Aster.
    Moist rich grounds, not abundant.
11. **A. oblongifolius**, Nutt.
    Rich grounds, scarce.
12. **A. Novæ-Angliæ**, L. New England Aster.
    Wet rich grounds, common. Aug., Nov.

Genus 8. **ERIGERON,** L. Fleabane.

1. **E. Canadense,** L. House Weed. Butter Weed.
   Old fields, common. July, Oct.
2. **A. divaricatum,** Michx.
   Dry sterile soil, not abundant. July, Sept
3. **E. bellidifolium,** Muhl.
   Borders of fields, thickets and streams, common. April, May.
4. **E. Philadelphicum,** L. Common Fleabane.
   Moist ground, common. June, July.
5. **E. annuum,** Pers. Daisy Fleabane. Sweet Scabious.
   Fence rows and meadows, common. May, Aug.
6. **E. strigosum,** Muhl. Daisy Fleabane.
   Fields and open woods, common.

Genus 9. **BOLTONIA.** L'Her.

1. **B. glastifolia,** L'Her.
   Moist rich soil, not common. Aug,, Sept.

Genus 10. **SOLIDAGO,** L. Golden Rod.

1. **S. cæsia,** L.
   Rich woods, frequent. Aug., Nov.
2. **S. rigida,** L. Rigid Golden-Rod.
   Moist prairies, rare. Aug., Oct.
3. **S. patula,** Muhl.
   Wet places, rare.
4. **S. altissima,** L.
   Old fields, very common and variable. Aug., Sept.
5. **S. ulmifolia,** Muhl.
   Moist fields and prairies. July, Sept.
6. **S. odora,** Ait. Sweet Golden-Rod.
   Sandy soil, scarce. July, Sept.
7. **S. nemoralis,** Ait.
   Moist prairies, with **S. rigida,** L, rare. Aug., Oct.
8. **S. Missouriensis,** Nutt.
   Dry sandy, but shady places, rare. Oct., Nov.
9. **S. Canadensis,** L. Colt's Tail.
   Very abundant and exceedingly variable.
10. **S. lanceolata,** L.
    Moist fields and glades, not rare. Aug., Sept.

Genus 11. **INULA,** L. Elecampane.

1. **I. Helenium,** L. Common Elecampane.
   Roadsides and woods, not rare. June, Sept. Nat. from Eu.

Genus 12. **PLUCHEA,** Cass. Marsh Fleabane.

1. **P. fœtida,** D. C.
   Rich clearings and moist glades, common. Aug. Sept.

Genus 13. **POLYMNIA**, L. Leaf-Cup.

1. **P. Uvedalia**, L.
Moist ravines and miry places, rare. Aug., Sept.

Genus 14. **SILPHIUM**, L. Rosin Plant.

1. **S. laciniatum**, L. Rosin Weed. Compass Plant.
Prairies and wet grounds, rare. June, Aug.
2. **S. terebinthinaceum**, L. Prairie Dock.
Fields and prairies, becoming rare. July, Sept.
3. **S. integrifolium**, Michx.
Fence rows and prairies, common. July, Sept.
4. **S. perfoliatum**, L. Cup Plant. Compass Plant.
Wet places along small streams. July, Aug.

Genus 15. **PARTHENIUM**, L.

1. **P. integrifolium**, L.
Clayey soil and moist prairies, not rare. June, Aug.

Genus 16. **AMBROSIA**, Tourn. Ragweed.

1. **A. bidentata**, Michx.
Dry prairies, common. July, Sept.
2. **A. trifida**, L. Great Ragweed. Horse-weed. Bitter-weed.
Rich river banks and fields, abundant and luxuriant. July, Sept.
3. **A. trifida**, var. **integrifolia**, Gray.
Rich upland soil, rare.
4. **A. artemisiæfolia**, L. Roman Wormwood. Hog Weed. Bitter Weed. Rag Weed.
Fields and woods, very abundant. Aug., Sept.
5. **A. psilostachya**, D. C.
Dry prairies and roadsides, common. Sept., Oct.

Genus 17. **XANTHIUM**, Tourn. Cocklebur. Clotbur.

1. **X. strumarium**, L. Common Cocklebur.
New rich fields and woods, common.

Genus 18. **ECLIPTA**, L.

1. **E. procumbens**, Michx.
Low moist banks, common. May, Oct. Exceedingly variable.
2. **E. procumbens**, var. **brachypoda**, Gray.
Wet places, not rare.

Genus 19. **HELIOPSIS**, Pers. Ox-Eye.

1. **H. lævis**, Pers.
Prairies and fields, rare. July, Aug.
2. **H. lævis**, var. **scabra**, Gray.
Fence-rows and prairies, common. July, Sept.

Genus 20. **ECHINACEA,** Mœnch. Purple Cone-Flower.

1. **E. purpurea,** Mœnch. Cone-Flower. Red Sun-Flower. Black Sampson.
   Prairies and thickets, rare. June, July.

Genus 21. **RUDBECKIA,** L. Cone-Flower.

1. **R. laciniata,** L. Cone-disk Sun-Flower. Tall Cone-Flower. Thimble-Weed. Negro's Heel.
   Fields and thickets, abundant. June, Aug.
2. **R. subtomentosa,** Pursh. Negro's Navel.
   Prairies and fence-rows, common. Aug., Sept.
3. **R. triloba,** L.
   Prairies and fields, common. July, Aug.
4. **R. hirta,** L.
   About gelds, &c., abundant. June, Aug.

Genus 22. **HELIANTHUS,** L. Sunflower.

1. **H. annuus,** L. Common Sunflower.
   Escaped from cultivation, July, Aug. Adv. from Trop. A.
2. **H. lætiflorus,** Pers.
   Dry prairies, scarce. Sept.
3. **H, mollis,** Lam.
   Prairies and fields, common. July, Sept. Often taken by mistake for **Silphium integrifolium,** Michx.
4. **H. microcephalus,** Torr. & Gray.
   Woods and thickets, rare.
5. **H. giganteus,** L.
   Moist places, common. Sept.
6. **H. grosse-serratus,** Martens.
   Moist prairies, not rare. Aug., Sept.

. **H. hirsutus,** Raf.
   Prairies and fence-rows, not scarce.

8. **H. tracheliifolius,** Willd.
   Copses, rare. Aug, Sept.
9. **H. decapetalus,** L.
   Open woods, fields and prairies, common.
10. **H. decapetalus,** var. **frondosus,** Gray.
   Rich grounds, common. Aug., Sept.
11. **H. doronicoides,** Lam.
   Woods and fields, not common.
12. **H. tuberosus,** L. Jerusalem Artichoke.
   Fields and fence-rows, common. Nat. from S. A.

Genus 23. **ACTINOMERIS,** Nutt.

1. **A. squarrosa,** Nutt.
   Rich grounds, not abundant. Aug., Sept.
2. **A. helianthoides,** Nutt.
   Copses and fields, common. June, Aug.

Genus 24. **COREOPSIS**, L. Tickseed.

1. **C. tripteris**, L. Tall Coreopsis.
   Borders of fields and prairies, not scarce. Aug., Sept.
2. **C. aristosa**, Michx. Prairie Spanish-Needles.
   Prairies and stubble fields, very abundant. Aug., Sept.

Genus 25. **BIDENS**, L. Burr Marigold.

1. **B. frondosa**, L. Common Beggar-ticks.
   Moist rich waste places, common. July, Oct.
2. **B. connata**, Muhl. Swamp Beggar-ticks.
   Wet banks, common. Aug., Oct.
3. **B. chrysanthemoides**, Michx. Barge Burr Marigold.
   Swampy and wet places, not common. July, Oct.
4. **B. bipinnata**, L. Spanish Needles.
   New rich fields and woods, too common.

Genus 26. **HELENIUM**, L. Sneeze-Weed.

1. **H. autumnale**, L. Sneeze-Weed. Swamp or False Sun-Flower.
   Moist thickets, not common. Aug., Oct. Always decidedly hairy.

Genus 27. **LEPTOPODA**, Nutt.

1. **L. brachypoda**, Torr. & Gray.
   Dry rich soil, scarce. June, Aug.

Genus 28. **MARUTA**, Cass. May-Weed.

1. **M. cotula**, D. C. Common May-Weed. Dog Fennel.
   Fields and roadsides, very abundant. May, Oct. Nat. from Eu.

Genus 29. **ACHILLEA**, L. Yarrow.

1. **A. millefolium**, L. Common Yarrow or Milfoil.
   Rich shaded woods and ravines, common. May, Dec.

Genus 30. **LEUCANTHEMUM**, Tourn. Ox-Eye Daisy.

1. **L. Parthenium**, Godron. Feverfew.
   Escaped from gardens. Adv. from Eu.

Genus 31. **TANACETUM**, L. Tansy.

1. **T. vulgare**, L. var. **crispum**. Common Tansy.
   Escaped from gardens to roadsides. July, Sept. Adv. from Eu.

Genus 32. **ARTEMISIA**, L. Wormwood.

1. **A. biennis**, Willd. Biennial Wormwood.
   Moist places, common. Aug., Sept.
2. **A. absinthium**, L. Common Wormwood.
   Escaped from gardens to old fields. Adv, from Eu.

Genus 33. **GNAPHALIUM**, L. Cudweed.

1. **G. polycephalum**, Michx. Common Everlasting. **Indian** Posey. Old-Field Balsam.
   Open woods and old fields, common. July, Aug.
2. **G. purpureum**, L. Purplish Cudweed.
   Dry sterile soil, not common.

Genus 34. **ANTENNARIA**, Gærtn. Everlasting.

1. **A. margaritacea**, R. Brown. Pearly Everlasting.
   Dry open woods, common. June, Aug.
2. **A. plantaginifolia**, Hook. Plantain-leaved Everlasting.
   Dry open sandy hillsides, common. March, May.

Genus 35. **ERECHTHITES**, Raf. Fireweed.

1. **A. hieracifolia**, Raf. Common Fireweed.
   New fields and clearings, abundant. July, Sept.

Genus 36. **CACALIA**, L. Indian Plantain.

1. **C. suaveolens**, L.
   Rich woods, rare. Aug., Sept.
2. **C. atriplicifolia**, L. Pale Indian Plantain.
   Rich woods and fields, not rare. July, Sept.

Genus 37. **SENECIO**, L. Groundsel

1. **S. aureus**, L. Golden Ragwort. Squaw-weed.
   Sandy banks. May, June.

Genus 38. **CENTAUREA**, L. Star-Thistle. **Bachelor's Button.**

1. **C. Cyanus**, L. Bluebottle.
   Escaped from gardens. June, July. Adv. from Eu.

Genus 39. **CIRSIUM**, Tourn. Common or Plumed **Thistle.**

1. **C. lanceolatum**, Scop. Common Thistle.
   Fields and open pastures, common. July, Sept. **Nat.** from Eu.
2. **C. discolor**, Spreng.
   Wet prairies, rare. Sept, Oct.
3. **C. altissimum**, Spreng.
   Fields and glades, common. Aug., Sept.

Genus 40. **LAPPA**, Tourn. Burdock.

1. **L. officinalis**, Allioni. Common Burdock.
   Fields and roadsides in rich grounds, common. June, Oct. A noisome weed. Nat. from Eu.

Genus 41. **CYNTHIA**, Don.

1. **C. Virginica**, Don.
   Moist shaded bluffs, rare. May, June.
2. **C. Dandelion**, D. C.
   Moist grounds, rare. April, June.

Genus 42. **HIERACIUM**, Tour. Hawkweed.

1. **H. scabrum**, Michx. Rough Hawkweed.
   Dry hilly open woods, rare. Aug., Sept.
2. **H. longipilum**, Torr. Long Bearded Hawkweed.
   Prairies and open woods, common. Aug., Sept.
3. **H. Gronovii**, L. Hairy Hawkweed.
   Dry clayey soil, not common. Aug., Sept.

Genus 43. **NABALUS**, Cass. Rattlesnake Root.

1. **N. altissimus**, Hook. Tall White Lettuce. Drop Flower.
   Rich woods, rare. Aug., Oct.

Genus 44. **TARAXACUM**, Haller. Dandelion.

1. **T. Dens-leonis**, Desf. Common Dandelion.
   Meadows and grassy places, very common. April, Nov.

Genus 45. **LACTUCA**, Tourn. Lettuce.

1. **L. Canadensis**, L. Wild Lettuce.
   Borders of fields, common. July, Sept.
2. **L. integrifolia**, Torr. & Gray.
   Fence rows and thickets, common. July, Sept.
3. **L. sanguinea**, Torr. and Gray.
   Fields and thickets, less common than the last two. The last three species are often found growing in the same fence corner, but always distinct.

Genus 46. **MULGEDIUM**, Cass. False or Blue Lettuce.

1. **M. acuminatum**, D. C.
   Thickets, not common. Aug., Sept.
2. **M. Floridanum**, D. C.
   Rich grounds, rare. Aug., Sept.
3. **M. leucophæum**, D. C.
   Loose shaded soil, rare.

ORDER 46. LOBELIACEÆ. LOBELIA FAMILY.

Genus 1. **LOBELIA**, L.

1. **L. cardinalis**, L. Cardinal Flower.
   Low moist grounds, common. July, Aug.
2. **L. syphilitica**, L. Great Lobelia.
   Low rich grounds, common, July, Sept.
3. **L. leptostachys**, A. D. C.
   Clayey soil, not rare. June, Sept.
4. **L. inflata**, L. Indian Tobacco.
   Almost all localities, abundant. July, Dec.

ORDER 47. CAMPANULACEÆ. CAMPANULA FAMILY.

Genus 1. **CAMPANULA,** Tourn. Bellflower.

1. **C. divaricata,** Michx.
   Hilly woods, rare.
2. **C. Americana,** L. American Bell. Tall Bellflower.
   Rich soil, fence rows and thickets, common. June, Sept.

Genus 2. **SPECULARIA,** Heister.

1. **S. perfoliata,** A. D. C. Venus, Looking-glass.
   Fence rows and open grounds, common. April, Aug.

ORDER 48. ERICACEÆ. HEATH FAMILY.

Genus 1. **MONOTROPA,** L. Indian Pipe. Pine Sap.

1. **M. uniflora,** L. Corpse Plant. Fit Plant. Bird's Nest.
   Shaded woods, not rare. June, Sept.

ORDER 49. AQUIFOLIACEÆ. HOLLY FAMILY.

Genus 1. **ILEX.** Holly.

1. **I. decidua,** Walt.
   Damp grounds, rare. May.
2. **I. verticillata,** Gray. Black Alder. Winterberry,
   Borders of ponds, &c., common. June.

ORDER 50. EBENACEÆ. EBONY FAMILY.

Genus 1. **DIOSPYROS,** L. Date Plum. Persimmon.

1. **D. Virginiana,** L. Common Persimmon.
   Scattered through woods and fields, but no where abundant.

ORDER 51. PLANTAGINACEÆ. PLANTAIN FAMILY.

Genus 1. **PLANTAGO,** L. Plantain. Ribgrass.

1. **P. major,** L. Common Plantain.
   About dwellings, &c., common. May, Aug. Nat. from Eu.
2. **P. cordata,** Lam.
   Muddy places, rare. May, June.
3. **P. Virginica,** L.
   Open sandy places and hillsides, common. May, Sept.

ORDER 52. PRIMULACEÆ. PRIMROSE FAMILY.

Genus 1. **DODECATHEON,** L. American Cowslip.

1. **D. Meadia,** L. Shooting Star. Pride of Ohio.
   Rocky bluffs, not rare. April, June.

Genus 2. **LYSIMACHIA**, Tourn. Loosestrife.

1. **L. ciliata**, L.
   Low thickets, common. June, July.
2. **L. lanceolata**, Walt.
   Rich grounds and thickets, not rare.
3. **L. lanceolata; var. angustifolia**, Gray.
   With the last, rare.
4. **L. longifolia**, Pursh.
   Low moist grounds, not common. June, Aug.
5. **L. nummularia**, L Moneywort.
   Escaped from cultivation, rare. July, Sept. Adv. from Eu.

Genus 3. **ANAGALLIS**, Tourn, Pimpernel.

1. **A. arvensis**, L. Common Red or Scarlet Pimpernel. Poor-Man's Weather-glass.
   Escaped from gardens, rare. Adv. from Eu.

Genus 4. **SAMOLUS**, L. Brook-weed.

1. **S. Valerandi**, L. var. **Americanus**, Gray. Water Pimpernel.
   Rich wet places, not abundant. June, Oct.

Genus 5. **HOTTONIA**, L. Featherfoil.

1. **H. inflata**, Ell. Water Violet.
   Muddy ponds, rare.

ORDER 53. LENTIBULACEÆ. BLADDERWORT FAMILY.

Genus 1. **UTRICULARIA**, L. Bladderwort.

1. **U. vulgaris**, L. Greater Bladderwort.
   Ponds, common.

ORDER 54. BIGNONIACEÆ. BIGNONIA FAMILY.

Genus 1. **BIGNONIA**, Tourn.

1. **B. capreolata**, L. Cross-Vine.
   Bottom lands along rivers, common. April, June. Leaves persist and retain verdure during mild winter until spring.

Genus 2. **TECOMA**, Juss. Trumpet Flower.

1. **T. radicans**, Juss. Trumpet Creeper.
   Rich woods and fields, common. June, Sept.

Genus 3. **CATALPA**, Scop., Walt. Indian Bean.

2. **C. bignonioides**, Walt. Catalpa, improperly called Patolpha.
   Bottom lands, common. May, June.

Genus 4. **MARTYNIA**, L, Unicorn Plant.

1. **M. proboscidea**, Glox. Devil's Claw.
   Sandy idle hillsides, not rare. June, Oct.

ORDER 55. **SCROPHULARIACEÆ.** FIGWORT FAMILY.

Genus 1. **VERBASCUM,** L Mullein.

1. **V. Thapsus,** L. Common Mullein.
   Fields and roadsides, abundant. June, Sept. Nat. from Eu.
2. **V. Blattaria,** L. Moth Mullein.
   Roadsides and about fields, common. May, Sept. Nat. from Eu.

Genus 2. **LINARIA,** Tourn. Toad-Flax.

1. **L. vulgaris,** Mill. Toad-Flax. Butter-and-eggs. Ramsted.
   Escaped to fields and roadsides, not rare. June, July. Nat. from Eu.

Genus 3. **ANTIRRHINUM,** L. Snapdragon.

1. **A. majus,** L. Large Snapdragon.
   Escaped from gardens, rare. Adv. from Eu.

Genus 4. **SCROPULARIA,** Tourn. Figwort.

1. **S. nodosa,** L. Carpenter's Square. Healall. Square Stick.
   Rich grounds, common. June, Sept.

Genus 5. **COLLINSIA,** Nutt.

1. **C. verna,** Nutt. Innocence.
   Rich soil, abundant. May, Aug.

Genus 6. **CHELONE,** Tourn. Turtle-Head. Snake-Head.

1. **C. glabra,** L. Salt-rheum Weed. Shell-Flower. Balmoney.
   Wet and boggy places, not common. July, Sept.

*2. **C. Lyoni,** Pursh.? Gray & Watson. **C. glabra,** L.? Dr. Engelman.
   Bottom lands and alluvial soil, not rare. July, Sept.

Genus 7. **PENSTEMON,** Mitchell. Beard-Tongue.

1. **P. pubescens,** Solander. Wild Foxglove.
   Moist grounds and meadows, abundant and variable. May. Sept.
2. **P. Digatalis,** Nutt.
   Moist rich soil, common. May, Aug.

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*_Remarks:_ From specimens sent Prof. Gray and Mr. Watson, they consider this to be identical with C. Lyoni, Pursh., but reserve a positive opinion until a more thorough investigation has been made; while Dr. Engelman thinks it may be C. glabra, L. During the last four seasons I have carefully observed the two plants in all stages of growth, and have noted the following difference: C. Lyoni? is usually found in woods in rich bottom lands and alluvial soil, from one to two, rarely three feet high; leaves from four to six inches long, by one to one and a half inches broad, and _smooth_ but _not shining_: flowers varying from purple to dark pink, from one and a half to one and three-quarters inches long. While C. glabra is usually from four to six feet high; grows in low and boggy places; leaves from two to four inches by one to one and a half inches, _smooth_ and _shining_; flowers a dull yellowish white, from one to one and a half inches long. These differences are constant.

Genus 8. **MIMULUS**, L. Monkey-Flower.

1. **M. ringens**, L.
   Wet places, common. July, Sept.
2. **M. alatus**, Ait.
   Low wet places, common. July, Sept.

Genus 9. **CONOBEA**, Aublet.

1. **C. multifida**, Benth.
   River banks, common. June, Sept. Corolna purplish, leaves in whorls of three towards the top.

Genus 10. **GRATIOLA**, L. Hedge-Hyssop.

1. **G. Virginiana**, L.
   Moist grounds, abundant. April, Sept.

Genus 11. **ILYSANTHES**, Raf.

1. **I. gratioloides**, Benth. False Pimpernel.
   Moist shaded places, not common. Aug., Oct.

Genus 12. **VERONICA**, L. Speedwell.

1. **V. Virginica**, L. Culver's-Root. Culver's-Physic. Black-Root.
   Rich grounds and fence-rows, not rare. June, Sept.
2. **V. serphyllifolia**, L. Thyme-leaved Speedwell.
   About old fields, common. April, Aug.
3. **V. peregrina**, L. Neckweed. Purslane, Speedwell.
   Waste and cultivated ground, common. May, Sept.
4. **V. arvensis**, L. Corn Speedwell.
   About dwellings and old fields, common. April, Aug. Nat. from Eu.

Genus 13. **SEYMERIA**, Pursh,

1. **S. macrophylla**, Nutt. Mullein Foxglove.
   Rich shaded soil, common. July, Sept.

Genus 14, **GERARDIA**, L.

1. **G. purpurea**, L. Purple Gerardia.
   Moist prairies, rare. Aug., Sept.
2. **G. aspera**, Dougl.
   Wet prairies.
3. **G. tenuifolia**, Vahl. Slender-leaved Gerardia.
   Dry woods and roadsides, very common. Aug., Oct.
4. **G. puercifolia**, Pursh. Smooth False Foxglove.
   Rich hilly shaded woods, not rare. Aug., Sept. Variable.

Genus 15. **CASTILLEIA**, Mutis. Painted Cup.

1. **C. coccinea**, Spreng. Scarlet Painted Cup.
   Prairies, rare. May, Aug.

Genus 16. **PEDICULARIS**, Tourn. Lousewort.

1. **P. lanceolata**, Michx.
   Wet woods, rare. Aug., Sept.

ORDER 56. ACANTHACEÆ. ACANTHUS FAMILY.

Genus 1. **DIANTHERA**, Gronov. Water Willow.

1. **D. Americana**, L.
   In the edge of streams, not rare. July, Sept.

Genus 2. **RUELLIA**, L.

1. **R. ciliosa**, Pursh.
   Dry open grounds, not rare. May, Sept.
2. **R. strepens**, L.
   Rich open grounds and glades, common. July, Sept. Mostly fruiting in the bud, (**Dipteracanthus micranthus**, Englm. & Gray.)

ORDER 57. VERBENACEÆ. VERVAIN FAMILY.

Genus 1. **VERBENA**, L. Vervain.

1. **V. hostata**, L. Blue Vervain. Wild Hyssop. Simpler's Joy.
   Low rich grounds, common. June, Sept.
2. **V. uriticifolia**, L. Nettle-leaved or White Vervain.
   Waste places and roadsides, abundant. July, Sept. Frequently hybridized with the last.
3. **V. stricta**, Vent. Hoary Vervain.
   Roadsides and barren soil, very abundant. June, Sept.
4. **V. bracteosa**, Michx.
   Open grounds and roadsides, common. June, Sept.
5. **V. Aubletia**, L.
   Prairies, rare, except in cultivation. June, Oct.

Genus 2. **LIPPIA**, L.

1. **L. lanceolata**, Michx. Fog Fruit.
   Damp grounds, not rare, June, Sept.

Genus 3. **PHRYMA**, L. Lopseed.

1. **P. Leptostachya**, L.
   Open woods. June, Aug.

ORDER 58. LABIATÆ. MINT FAMILY.

Genus 1. **TEUCRIUM**, L. Germander.

1. **T. Canadense**, L. American Germander. Wood Sage.
   Moist rich soil, abundant. June, Sept.

Genus 2. **MENTHA**, L. Mint.

1. **M. viridis**, L Spearmint.
   Wet places, not common. Nat. from Eu.
2. **M. piperita**, L. Peppermint.
   Moist rich soil, not rare. Nat. from Eu.
3. **M. arvensis**, L. Corn Mint.
   Damp fields, not rare. Nat.? from Eu
4. **M. Canadensis**, L. Wild Mint,
   Moist situations along streams, common. July, Oct.

Genus 3, **LYCOPUS**, L. Water Hoarhound.

1. **L. Virginicus**, L. Bugle Weed. Pond Betony.
   Wet places, not rare. July, Sept.
2. **L. Europæus**, L.
   Moist localities, common. July, Oct. Very variable in form and color.

Genus 4. **CUNILA**, L. Dittany.

1. **C. Mariana**, L. Common Dittany. Stone Mint. Mountain Dittany.
   Dry rocky hills, rare. June, Oct.

Genus 5. **PYCNANTHEMUM**, Michx. Basil. Mountain Mint.

1. **P. incanum**, Michx.
   About fields, not rare. July, Sept.
2. **P. pilosum**, Nutt.
   Dry grounds, common. July, Aug.
3. **P. muticum**, Pers.
   Dry sandy soil. July, Aug.
4. **P. lanceolatum**, Pursh.
   About dry sandy fields, common. July, Aug.
5. **P. linifolium**, Pursh.
   Fields and open grounds, common. June, Sept.

Genus 6. **SATUREIA**, L. Savory.

1. **S. hortensis**, L. Summer Savory.
   Escaped from gardens to roadsides and fence-rows. June, Sept. Nat. from Eu.

Genus 7. **HEDEOMA**, Pers. Mock Penny-royal.

1. **H. pulegioides**, Pers. American Pennyroyal.
   Fields and roadsides, very abundant. July, Sept.

Genus 8. **COLLINSONIA**, L. Horse-balm. Hardhack.

1. **C. Canadensis**. L. Rich-weed. Stone-root. Heal-all. Ox-Bahn. Horse-weed.
   Rich woods, rare. July, Aug.

Genus 9. **MONARDA**, L. Horse Mint.

1. **M. didyma,** L. Oswego Tea.
   Escaped from gardens. June, Aug. Adv. from N. & E. U. S.
2. **M. fistulosa**, L. Wild Bergamot.
   Rich grounds, common. June, Sept.
3. **B. Bradburiana**, Beck.
   Open woods and fence-rows, common. May, July.

Genus 10. **BELPHILIA**, Raf.

1. **B. ciliata**, Raf.
   Dry woods and fields, common. June, July.
2. **B. hirsuta**, Benth.
   Rich woods, rare. July, Oct.

Genus 11. **LOPHANTHUS**, Benth. Giant Hyssop.

1. **L. nepetoides**, Benth.
   Woods and fence-rows, not rare. July, Sept.
2. **L. scrophulariæfolius**, Benth.
   Woods and fields, common. July. Sept.

Genus 12. **NEPETA**, L. Cat Mint.

1. **N. Cataria**, L. Catnip.
   Dwelling places, fields and roadsides, abundant. May, Sept. Nat. from Eu.
2. **N. Glechoma**, Benth. Ground Ivy. Gill-over-the-Grounds.
   Low damp grounds, too common. April, Aug. Strongly but not unpleasantly scented. When once started it soon spreads over large patches of ground, making itself a nuisance. Nat. from Eu.

Genus 13. **PHYSOSTEGIA**, Benth. False Dragon-head.

1. **P. Virginiana**, Benth. Lion's Heart.
   Low, wet places, scarce. July, Sept.

Genus 14. **BRUNELLA**, Tourn. Self-Heal.

1. **B. vulgaris**, L. Common Self-Heal or Heal-all.
   Woods and fence-rows, common. May, Sept.

Genus 15. **SCUTELLARIA**, L. Skullcap.

1. **S. canescens**. Nutt.
   Rich, hilly woods, common. June, Sept.
2. **S. serrata**, Andrews.
   Woods and fields, not common. July, Aug.
3. **S. nervosa**, Pursh.
   Moist rich places, rare.
4. **S. parvula,** Michx.
   Damp rich grounds and prairies, common. May, June.

5. **S. lateriflora,** L. Blue Skullcap. Side-Flowering Skullcap. Mad-dog Weed. Mad-dog Skullcap.
Moist shaded places and swamps, common. Aug., Oct.

Genus 16. **MARRUBIUM,** L. Hoarhound.

1. **M. vulgare,** L. Common Hoarhound.
About dwellings and roadsides, common. June, Sept. Nat. from Eu.

Genus 17. **STACHYS,** L. Hedge-Nettle.

1. **S. palustris,** L.
Wet places and swamps, not rare. July, Aug.
2. **S. palustris,** var. **aspera,** Gray.
Wet grounds, rare.
3. **S. palustris,** var. **glabra,** Gray.
Moist places, scarce. July, Aug.
4. **S. palustris,** var. **cordata,** Gray.
Moist places, common. June, Sept. All exceedingly variable, and gradually run into one another.

Genus 18. **LEONURUS,** L. Motherwort.

1. **L. Cardisca,** L. Common Motherwort.
About dwellings and fields, common. May, Sept. Nat. from Eu.

Genus 19. **PERILLA.**

1. **P. ocymoides,** var. **crispa.** Perilla Nankinensis.
Escaped from gardens, and almost naturalized. July, Nov.

ORDER 59. BORRAGINACEÆ. BORAGE FAMILY.

Genus 1. **SYMPHYTUM,** Tourn. Comfrey.

1. **S. officinale,** L. Common Comfrey.
Escaped from gardens, rare. June, July. Adv. from Eu.

Genus 2. **LITHOSPERMUM,** Tourn. Gromwell. Puccoon.

1. **L. angustifolium,** Michx.
Rich sandy woods and fields, common. May, June.
2. **L. latifolium,** Michx.
Hilly woods, rare.
3. **L. hirtum,** Lehm. Hairy Puccoon.
Dry hilly woods, scarce. April, May.

Genus 3. **MERTENSIA,** Roth. Smooth Lungwort.

1. **M. Virginica,** D.C. Virginian Cowslip, or Lungwort. Blue-Bell.
Rich woods and new fields, rapidly becoming extinct, except in gardens. April, May.

Genus 4. **MYOSOTIS**, L. Scorpion-grass. Forget-me-not.

1. **M. verna**, Nutt.
About fields, not common. April, June.

Genus 5. **ECHINOSPERMUM**, Swartz. Stickseed.

1. **E. Lapula**, Lehm.
Idle places, not common. Nat. from Eu.

Genus 6. **CYNOGLOSSUM**, Tourn. Hound's Tongue.

1. **C. officinale**, L. Common Hound's Tongue.
About old fields and roads, scarce. June, July. Nat. from Eu.
2. **C. Virginicum**, L. Wild Comfrey.
Rich open woods, common. June.
3. **C. Morisoni**, D. C. Beggar's-Lice. Dysentery-Weed. Virginia Mouse-ear.
Copses, rich woods and fields, common. July, Sept.

Genus 7. **HELIOPHYTUM**, Cham., D. C.

1. **H. Indicum**, D. C. Indian Heliotrope.
Rich manured grounds and river banks, common. May, Aug. Nat. from India.

ORDER 60. HYDROPHYLLACEÆ. WATERLEAF FAMILY.

Genus 1. **HYDROPHYLLUM**, L. Waterleaf.

1. **H. macrophyllum**, Nutt.
Rich shaded grounds, not rare. May, June.
2. **H. appendiculatum**, Michx.
Rich banks, not common.. June, July.

Genus 2. **PHACELIA**, Juss.

1. **P. bipinnatifida**, Michx.
Rich shaded grounds, common. April, June. Strongly but very unpleasantly scented.
2. **P. Purshii**, Buckley.
Rich wooded banks, rare. April, June.

ORDER 61. POLEMONIACEÆ. POLEMONIUM FAMILY.

Genus 1. **POLEMONIUM**, Tourn. Greek Valerian.

1. **P. reptans**, E. American Greek Valerian. Blue Bell. Hare Bell. White Snakeroot.
Woods and fields, common, April, June. Whole plant decidedly hairy instead of smooth, as described in text books.

Genus 2. **PHLOX**, L.

1. **P. paniculata**, L.
Low rich places in woods and fields, common. July, Aug.
2. **P. paniculata** var. **acuminata**, Gray.
Wet prairies, rare.
3. **P. maculata**, L. Wild Sweet William.
Wet grounds, not rare. June, July.
4. **P. glaberrima**, L.
Low moist prairies, not rare. June, Aug.
5. **P. pilosa**, L.
Woods, thickets and prairies, abundant and exceedingly variable in width of leaves and color of flowers. April, June.
6. **P. procumbens**, Lehm.
Hilly woods, rare. April, June.
7. **P. divaricata**, L.
Hilly woods, common. April, June.

ORDER 62. CONVOLVULACEÆ. CONVOLVULUS FAMILY.

Genus 1. **QUAMOCLIT**, Tourn. Cypress Vine.

1. **Q. coccinea**, Mœnch.
River banks and fence rows. July, Sept. Nat. from Trop. Amer.

Genus 2. **IPOMŒA**, L. Morning Glory.

1. **I. purpurea**, Lam. Common Morning Glory.
Escaped from cultivation to fields. July, Oct. Adv. from Trop. America.
2. **I. Nil**, Roth. Smaller Morning Glory.
Fields and woods, common. July, Oct. Nat. from Trop. America.
3. **I. lacunosa**, L.
Bottom lands in fields and woods. Aug., Oct.
4. **I. pandurata**, Meyer. Wild Potato Vine. Man-of-the-Earth. Wild Jalap.
Sandy fields and thickets, common. June, Aug.

Genus 3. **CALYSTEGIA**, R. Br. Bracted Bindweed.

1. **C. sepium**, R. Br. Hedge Bindweed.
Rich moist places in fields and thickets, common. June, Sept.

Genus 4. **CUSCUTA**, Tourn. Dodder.

1. **C. Gronovii**, Willd.
   Rich places and thickets, common. July, Sept.
2. **C. compacta**, Juss.
   Rich moist places, common. Aug., Sept.
3. **C. glomerata**, Choisy.
   Same locality as the last, not rare. July, Sept.

ORDER 63. SOLANACEÆ. NIGHTSHADE FAMILY.

Genus 1. **SOLANUM**, Tourn. Nightshade.

1. **S. Dulcamara**, L. Bittersweet. Woody Nightshade. Violet Bloom. Scarlet Berry.
   River bottoms and about dwellings, rare. June, Sept. Nat. from Eu.
2. **S. nigrum**, L. Common or Black Nightshade.
   Woods and fields, common. July, Nov. Nat. from Eu.
3. **S. Carolinense**, L. Horse or Bull Nettle.
   Cultivated grounds and shaded woods, abundant. June, Sept.

Genus 2. **PHYSALIS**, L. Ground Cherry.

1. **P. pubescens**, L.
   Rich grounds in fields and glades. June, Sept.
2. **P. viscosa**, L. Yellow Henbane.
   Fields and woods, not common. June, Aug.
3. **P. Pennsylvanica**, var. **Lanceolata**, Gray.
   Dry woods and fields, common. June, July.

Genus 3. **NICANDRA**, Adans. Apple of Peru.

1. **N. physaloides**, Gærtn.
   Waste grounds about dwellings and farms. June, Aug. Nat. from Peru. Flowers begin to open at 12 M., and are closed again at 5 P. M.

Genus 4. **LYCIUM**, L. Matrimony-Vine.

1. **L. vulgare**, Dunal. Common Matrimony-Vine. Jassamine.
   Escaped from cultivation to old fields and steep banks, April, Aug. Nat. from Eu.

Genus 5. **DATURA**, L. Jamestown-Weed. Thorn-Apple.

1. **D. Stramonium**, L. Common Stramonium or Thorn-Apple.
   Rich idle grounds, not common. Nat. from Asia.
2. **D. Tatula**, L. Purple Thorn-Apple.
   Fields, roadsides and open woods, abundant. July, Sept. Nat. from Trop. Amer.

Genus 8. **PETUNIA**, Juss.

1. **P. Nyctaginiflora**, Juss. Common Petunia.
Escaped from gardens. July, Sept. Adv. from S. A. For several years I have found this growing about dwellings and roadsides. Of specimens sent Prof. Gray, he remarks: "A cross of the two species, mainly Nyctaginaflora."

ORDER 64. GENTIANACEÆ. GENTIAN FAMILY.

Genus 1. **SABBATIA**, Adans. American Centaury.

1. **S. angularis**, Pursh. Centaury Plant. Rose-Pink.
Dry grounds, scarce. July, Sept.

Genus 2. **FRASERA**, Walt. American Columbo.

1. **F. Carolinensis**, Walt.
Hilly woods, not rare. June, July.

Genus 3. **GENTIANA**, L. Gentian.

1. **G. alba**, Muhl. Whitish Gentian.
Hilly woods and rocky bluffs, rare. Sept., Nov.
2. **G. Andrewsii**, Griseb. Closed Blue-Gentian.
Rich hilly woods, not rare. Sept., Nov.

Genus 4. **OBOLARIA**, L.

1. **O. Virginica**, L.
Rich moist soil near streams, rare.

ORDER 65. APOCYNACEÆ. DOGBANE FAMILY.

Genus 1. **AMSONIA**, Walt.

1. **A. Tabernæmontana**, Walt.
Low wet grounds, frequent. May, June.

Genus 2. **APOCYNUM**, Tourn. Dogbane. Indian Hemp.

1. **A. cannabinum**, L. Indian Hemp.
Banks of streams and about fields, common. June, Aug.
2. **A. cannabinum**, var. **pubescens**, D. C.
About fields and fence-rows, not rare. June, Aug.

ORDER 66. ASCLEPIADACEÆ. MILKWEED FAMILY.

Genus 1. **ASCLEPIAS**, L. Milkweed. Silkweed.

1. **A. Cornuti**, Decaisne. Common Milkweed or Silkweed.
Rich sandy grounds, not common.
2. **A. purpurascens**, L. Purple Milkweed.
Low moist grounds and prairies, common. June, Aug.

3. **A. variegata,** L. Variegated Milkweed.
   Woods and fields, rare.
4. **A. perennis,** Walt.
   Low grounds, not rare. June, Aug.
5. **A. incarnata,** L. Swamp Milkweed.
   Wet grounds in alluvial soil, common. July, Aug.
6. **A. tuberosa,** L. Butterfly-weed. Pleurisy Root. **Wind Root.**
   Prairies and fence-rows, becoming rare. June, Aug.

Genus 2. **ACERATES,** Ell. Green Milkweed.

1. **A. longifolia,** Ell.
   Wet prairies, rare. July, Oct.

Genus 3. **ENSLENIA,** Nutt.

1. **E. albida,** Nutt.
   River banks, common. July, Sept.

Genus 4. **GONOLOBUS,** Michx.

1. **G. lævis,** Michx.
   Alluvial soil, rare. June, July.

Order 67. OLEACEÆ. Olive Family.

Genus 1. **LIGUSTRUM,** Tourn. Privet.

1. **L. vulgare,** L. Common Privet or Prim.
   Occasionally found in fields and woods. Nat. from Eu.

Genus 2. **FRAXINUS,** Tourn. Ash.

1. **F. Americana,** L. White Ash.
   Rich woods, common.
2. **F. virides,** Michx. f. Green Ash.
   Wet places, not rare.
3. **F. sambucifolia,** Lam. Black or Water Ash.
   Swamps and wet places, not rare.
4. **F. quadrangulata,** Michx. Blue Ash.
   Rich hilly woods, rare.

Genus 3. **FORESTIERA,** Poir.

1. **F. acuminata,** Poir.
   River banks and alluvial soil. March, April.

Order 68. ARISTOLOCHIACEÆ. Birthwort Family.

Genus 1. **ASARUM,** Tourn. Asarabacca. Wild Ginger.

1. **A. Canadense,** L. Indian Ginger. Colt's Foot. Canada Snakeroot.
   Shaded, hilly, rich woods, common. April, May.

Genus 2. **ARISTOLOCHIA**, Tourn. Birthwort.

1. **A. Serpentaria**, L. Virginia Snakeroot. Snakeroot. Snakeweed.
   Loose rich earth, common. May, June.
2. **A. tomentosa**, Sims. Pipe Vine.
   Rich river banks, not rare. May, June.

ORDER 69. PHYTOLACCACEÆ. POKE WEED FAMILY.

Genus 1. **PHYTOLACCA**, Tourn. Pokeweed.

1. **P. decandra**, L. Common Poke or Scoke. Gargetweed. Pigeonberry. Coakum.
   Rich grounds and fence rows, common. June, Aug.

ORDER 70. CHENOPODIACEÆ. GOOSEFOOT FAMILY.

Genus 1. **CHENOPODIUM**, L. Goosefoot. Pigweed.

1. **C. album**, L. Lamb's Quarters. Pigweed.
   Fields and fence rows, common. Aug., Oct. Nat. from Eu.
2. **C. viride**, L.
   Same locality as the last but more common. June, Sept. Nat. from Eu. The last two appear to be entirely distinct species with us. The following are the most prominent differences: 1st, **C. viride** is from six to eight weeks earlier in bloom; 2d, its leaves are longer, much narrower, more entire and a deeper green; 3d, these differences are constant; they do not grade into one another.
3. **C. ambrosioides**, L. Mexican Tea.
   Sandy drifts and river banks, not rare. July, Aug. Nat. from Trop. Amer. Very strongly but not unpleasantly scented.
4. **C. anthelminticum**. L. Wormseed. Jerusalem Oak.
   Old fields and dwellings, common. July, Sept. Nat. from Trop. Amer. Very strongly and decidedly unpleasantly scented. Appears entirely distinct from the last, here.

ORDER 71. AMARANTACEÆ. AMARANTH FAMILY.

Genus 1. **AMARANTUS**, Tourn. Amaranth.

1. **A. hypochondriacus**, L. Prince's Feather.
   Escaped from gardens, rare. Aug., Oct. Adv. from Trop. Amer.
2. **A. paniculatus**, L. Careless-Weed.
   About fields and idle places, common. Nat. from Trop. Amer.

3. **A. retroflexus**, L. Careless-Weed.
Cultivated grounds and borders of woods. Nat. from Trop. Amer.

4. **A. spinosa**, L. Thorny Amaranth.
Fields and open grounds, everywhere. Sept. Of recent introduction, but rapidly spreading, to the great annoyance of farmers, who usually call it Canada Thistle. Nat. from Trop. Amer.

Genus 2. **MONTELIA**, Moquin.

1. **M. tamariscina**, Gray.
Sand-bars along streams, common. July, Sept.

Genus 3. **IRISCINE**, P. Browne.

1. **I. celosioides**. L.
River bottoms and alluvial soil, rare. Sept., Oct.

ORDER 72. POLYGONACEÆ. BUCKWHEAT FAMILY.

Genus 1. **POLYGONUM**, L. Knotweed.

1. **P. orientale**, L. Prince's Feather. Lady's Finger.
Escaped from gardens, not common. July, Sept. *Adv.* from India.

2. **P. Pennsylvanicum**, L.
Rich grounds, abundant. July, Dec.

3. **P. incarnatum**, Ell.
Wet places, common. July, Sept.

4. **P. Persicaria**, L. Lady's Thumb.
Damp waste places, common. Aug., Sept.

5. **P. Hydropiper**, L. Common Smartweed or Water-Pepper.
Wet heavy grounds, common.

6. **P. hydropiperoides**, Michx. Mild Water-Pepper.
Wet places, abundant. June, Aug.

7. **P. amphibium**, L. Water Persicaria.
Borders of ponds, common. Aug., Oct.

8. **P. amphibium**, var. **aquaticum**, Willd.
Shallow muddy ponds, not common.

9. **L. Virginicum**, L.
Thickets, common. Aug., Sept.

10. **P. aviculare**, L. Knotgrass. Goose-grass. Door-weed.
Waste places and about dwellings, abundant. June, Sept.

11. **P. aviculare**, var. **erectum**, Roth.
Moist rich grounds about dwellings, common. June, Sept.

12. **P. sagittatum**, L. Arrow-leaved Tear-thumb.
Moist grounds, common. July, Oct.

13. **P. dumetorum**, L. Climbing False Buckwheat.
Clayey soil, rare.

14. **P. dumetorum**, var. **scandens**, Gray.
Moist rich soil in thickets and fence-rows, common. Aug., Oct.

Genus 2. **FAGOPYRUM**, Tourn. Buckwheat.

1. **F. esculentum**, Mœnch. Common Buckwheat.
Occasionally found escaped from fields. Adv. from Eu.

Genus 3. **RUMEX**, L. Dock Sorrel.

1. **R. Britannica.** L. Pale Dock.
Moist rich grounds, common. May, July.

2. **R. verticillatus**, L. Swamp Dock.
Muddy borders of ponds, common.

3. **R. crispus**, L. Curled Dock.
Fields and barnyards, a detested weed. May, Aug. Nat. from Eu.

4. **R. obtusifolius**, L. Bitter Dock.
About dwellings and cultivated grounds. Nat. from Eu.

5. **R. sanguineus**, L. Bloody-veined Dock.
Rich grounds about fields, rare. June, Sept. Nat. from Eu.

6. **R. Acetosella**, L. Field or Sheep Sorrell.
Sandy soil, common. May, Sept.

Order 73. LAURACEÆ. Laurel Family.

Genus 1. **SASSAFRAS**, Nees.

1. **S. officinale**, Nees. Red and White Sassafras.
Rich woods, common.

Genus 2. **LINDERA**, Thunberg. Wild Allspice. Fever-bush.

1. **L. Benzoin**, Meisner. Spice-bush. Benjamin-bush.
Wet rich woods, not rare. March, April.

Order 74. LORANTHACEÆ. Mistletoe Family.

Genus 1. **PHORADENDRON**, Nutt. False Mistletoe.

1. **P. flavescens**, Nutt. American Mistletoe.
On trees, most frequently on the American Elm. April.

Order 75. SAURURACEÆ. Lizard's-tail Family.

Genus 1. **SAURURUS**, L. Lizard's Tail.

1. **S. cernuus**, L.
Wet swampy places, common. June, Aug.

ORDER 76. CERATOPHYLLACEÆ. HORNWORT.

Genus 1. CERATOPHYLLUM, L. Hornwort.

1. **C. demersum**, L.
   Ponds, not common.

ORDER 77. CALLITRICHACEÆ. WATER STARWORTS.

Genus 1. CALLITRICHE, L. Water Starwort.

1. **C. luterophylla**, Pursh.
   Ponds, not rare.

ORDER 78. EUPHORBIACEÆ. SPURGE FAMILY.

Genus 1. EUPHORBIA, L. Spurge.

1. **E. maculata**, L.
   Forming plots on barren clayey hillsides, common. Aug., Oct.
2. **E. hypericifolia**, L. Large Spotted Spurge. Black or Milk Pursley.
   Cultivated grounds, very common. June, Aug.
3. **E. marginata**, Pursh.
   Escaped from gardens, rare. Adv. from Western plains.
4. **E. corollata**, L. Large Flowering Spurge. Blooming Spurge. Milkweed.
   Fields and open grounds, common. July, Oct.
5. **E. obtusata**, Pursh.
   River bottoms, rare. June, July.
6. **E. Esula**, L. Garden Pine.
   Escaped from gardens to old rich soil, almost naturalized. May, Aug. Adv. from Eu.

Genus 2. ACALYPHA, L. Three-seeded Mercury.

1. **A. Virginica**, L.
   Dry shaded woods, common.
2. **A. Virginica** var. **gracileus**, Gray. June, Sept.
   Less common than the last.

Genus 3. PHYLLANTHUS, L.

1. **P. Carolinensis**, Walt.
   Dry prairies and woods, not rare. July, Sept.

ORDER 79. URTICACEÆ. NETTLE FAMILY.

Genus 1. ULMUS, L. Elm.

1. **U. fulva**, Michx. Slippery or Red Elm.
   Moist rich soil, not abundant.

2. **U. Americana**, Willd. American or While Elm.
Low rich woods, abundant.
3. **U. alata**, Michx. Wahoo or Winged Elm.
Banks of streams, rare.

Genus 2. **CELTIS**, Tourn. Nettle-tree. Hackberry.

1. **C. occidentalis**, L. Sugarberry. Hackberry.
Bottom lands, common.
2. **C. occidentalis**, var. **Mississippiensis**, Bosc.
Same locality as the last, less common.

Genus 3. **MORUS**, Tourn. Mulberry.

1. **M. rubra.** Red or Common Mulberry.
Scattered through the woods, and found in almost all localities, not abundant in any spot.
2. **M. alba**, L. White Mulberry.
Escaped from cultivation. Adv. from Eu.

Genus 4. **URTICA**, Tourn. Nettle.

1 **U. gracilis**, Ait.
Moist rich grounds, not common. July, Aug.

Genus 5. **LAPORTEA**, Gaudichaud. Wood Nettle.

1. **L. Canadensis**, Gaudichaud.
Rich shaded woods. July, Sept.

Genus 6. **PILEA**, Lindl.

1. **P. pumila**, Gray. Richweed. Clearweed.
Shaded rich grounds, common. June, Oct.

Genus 7. **BŒHMERIA**, Jacq. False Nettle.

1. **B. cylindrica**, Willd.
Moist grounds, common.

Genus 8. **PARIETARIA**, Tourn. Pellitory.

1. **P. Pennsylvanica**, Muhl.
Shaded banks, rare.

Genus 9. **CANNABIS**, Tourn. Hemp.

1. **C. sativa**, L. Hemp.
Waste grounds and fence-rows, common. July, Aug. Nat. from Eu.

Genus 10. **HUMULUS**, L. Hop.

1. **H. Lupulus**, L. Common Hop.
Rich loose earth and thickets, not rare. July, Aug.

Order 80. PLATANACEÆ. Plane-Tree Family.

Genus 1. **PLATANUS**, L. Plane-Tree. Buttonwood.

1. **P. occidentalis**, L. American Plane-Tree. Sycamore.
Banks of streams and alluvial soil, common.

ORDER 81. JUGLANDACEÆ. WALNUT FAMILY.

Genus 1. JUGLANS, L. Walnut.

1. **J. cinerea**, L. Butternut. White Walnut.
   Broken grounds, scarce.
2. **J. nigra**, L. Black Walnut.
   Rich soil, common.

Genus 2. CARYA, Nutt. Hickory.

1. **C. olivæformis**, Nutt. Pecan-nut.
   Bottom lands and alluvial soil, not rare.
2. **C. alba**, Nutt. Shell-bark. Shag-bark Hickory.
   Rich sand ridges in bottom lands, common.
3. **C. microcarpa**, Nutt. Small-fruited Hickory.
   Heavy damp soil, scarce. Has very little loose bark, one of our smallest hickorys.
4. **C. sulcata**, Nutt. Western Shell-bark Hickory.
   Most common along streams.
5. **C. tomentosa**, Nutt. Mocker-nut. Black Hickory. White-heart Hickory.
   Common.
6. **C. porcina**, Nutt. Broom Hickory.
   Upland woods, scarce.
7. **C. amara**. Bitter-nut. Pig-nut. Swamp Hickory.
   Rich soil, scarce.

ORDER 82. CUPULIFERÆ. OAK FAMILY.

Genus 1. QUERCUS. L. Oak.

1. **Q. alba**, L. White Oak.
   Rich hilly woods, abundant.
2. **Q. obtusiloba**, Michx. Post Oak. Rough or Box White Oak. Iron Oak. Turkey Oak.
   Wet clayey soil, not common.
3. **Q. macrocarpa**, Michx. Burr Oak. Over-cup Oak. Mossy-cap White Oak.
   Alluvial soil and bottom lands, common.
4. **Q. bicolor**, Willd. Swamp White Oak.
   Wet grounds, common.
5. **Q. Prinus**, L. Chestnut Oak.
   Alluvial soil, scarce.
6. **Q. Prinus var. acuminata**, Michx. Yellow Chestnut Oak. Chinquapin Oak.
   Hillsides and river banks, frequent.
7. **Q. Phellos**, L. Willow Oak.
   Rich sandy soil, rare.

8. **Q. imbricaria**, Michx. Laurel or Shingle Oak.
Low rich and prairie soil, abundant.

9. **Q. nigra**, L. Black-Jack or Barren Oak.
Dry sandy barrens, where it is common.

10. **Q. falcata**, Michx. Spanish Oak.
Low grounds, very rare.

11. **Q. coccinea**, Wang. Scarlet Oak.
Bottom lands and grown up prairies, abundant.

12. **Q. coccinea**, var. **tinctoria**, Gray. Quercitron. Yellow Barked or Black Oak.
With the last, common.

13. **Q. rubra**, L. Red Oak.
Banks of streams and low grounds, common.

14. **Q. palustris**, Du Roi. Swamp Oak. Pin Oak.
Wet soil, abundant.

Genus 2. **CASTANEA**, Tourn. Chestnut.

1. **C. vesca** var. **Americana**, Michx. Chestnut.
A few scattered trees have been found, probably not a native of our vicinity.

Genus 3. **FAGUS**. Tourn. Beech.

1. **F. ferruginea**, Ait. American Beech.
Rich woods; usually found in patches, where it is the principal timber.

Genus 4. **CORYLUS**, Tourn. Hazelnut. Filbert.

1. **C. Americana**, Walt. Wild Hazlenut.
Rich woods, forming thickets, common.

Genus 5. **OSTRYA**, Mich. Hop Hornbeam. Iron Wood.

1. **O. Virginica**, Willd. American Hop Hornbeam. Lever Wood.
River banks, very rare.

Genus 6. **CARPINUS**, D. Hornbeam. Iron Wood.

1. **C. Americana**, Michx. American Hornbeam. Common Iron Wood. Blue or Water Beech.
Rich woods, common.

Order 83. BETULACEÆ. Birch Family.

Genus 1. **BETULA**, Tourn. Birch.

1. **B. lenta**, L. Cherry, Sweet, Black or Mahogany Birch.
Banks of streams, not abundant.

2. **B. nigra**, L. River or Red Birch.
Wet banks, rare.

Genus 2. **ALNUS**, Tourn. Alder.

1. **A. serrulata**, Ait. Smooth Alder.
About ponds and banks of streams, common.

ORDER 84. SALICACEÆ. WILLOW FAMILY.

Genus 1. SALIX, Tourn. Willow. Osier.

1. **S. tristis,** Ait. Dwarf Gray Willow.
   Along small streams, common.
2. **S. humilis,** Marshall. Prairie Willow.
   Prairies and low grounds, common.
3. **S. discolor,** Muhl. Glaucous Willow.
   Moist banks and along streams, rare.
4. **S. petiolaris,** Smith. Petioled Willow.
   Wet places, common.
5. **S. lucida,** Muhl. Shining Willow.
   Moist banks of streams, common.
6. **S. nigra,** Marsh, Black Willow.
   About wet places and streams, common.
7. **S. alba,** var. **vitellina.** Yellow Willow. Golden Osier.
   Wet places and along small streáms, not rare. Nat. from Eu.

Genus 2. POPULUS, Tourn. Poplar. Aspen.

1. **P. tremuloides,** Michx. American Aspen.
   Upland woods, rare.
2. **P. heterophylla,** L. Downy Poplar. Cotton Tree.
   Swamps and alluvial soil, scarce.
3. **P. monilifera,** Ait. Cotton Wood. Necklace Poplar.
   Borders of streams, common.
4. **P. alba,** L. White Poplar. Silver-leaf Poplar.
   Spreading from cultivation. Adv. from Eu.

ORDER 85. CONIFERÆ. PINE FAMILY.

Genus 1. PINUS, Tourn. Pine.

1. **P. mitis,** Michx. Yellow Pine.
   Hills near the mouth of the Wabash river, in Gallatin Co., Illinois

Genus 2. CUPRESSUS, Tourn. Cypress.

1. **C. thyroides,** L. White Cedar.
   Wet places near the mouth of the Wabash river.

Genus 3. TAXODIUM, Richard. Bald Cypress.

1. **T. distichum,** Richard. American Bald Cypress.
   Swamps, where it sometimes forms the principal growth.

Genus 4. JUNIPERUS, L. Juniper.

1. **J. communis,** L. Common Juniper.
   Rich woods, rare.
2. **J. Virginiana,** L. Red Cedar or Savine.
   Rocky hills in Gallatin Co., Ill. Near the mouth of Wabash river.

ORDER 86. ARACEÆ. ARUM FAMILY.

Genus 1. **ARISÆMA,** Martius. Indian Turnip. Dragon Arum.

1. **A. triphyllum,** Torr. Indian Turnip. Jack-in-the-pulpit. Wake Robin.
   Rich woods, not rare. May.
2. **A. Dracontium,** Schott. Green Dragon. Dragon-Root.
   Low rich grounds, common. May.

Genus 2. **SYMPLOCARPUS,** Salisb. Skunk Cabbage.

1. **S. fœtidus,** Salisb.
   Boggy places, rare.

Genus 3. **ACORUS,** L. Sweet Flag.

1. **A. calamus,** L.
   Miry places about streams, not rare.

ORDER 87. LEMNACEÆ. DUCKWEED FAMILY.

Genus 1. **LEMNA,** L. Duckweed. Duck's-meat.

1. **L. minor,** L.
   Stagnant waters, rare.
2. **L. polyrrhiza,** L.
   Still waters, and drifts in streams, common.

ORDER 88. TYPHACEÆ. CAT-TAIL FAMILY.

Genus 1. **TYPHA,** Tourn. Cat-tail Flag.

1. **T. latifolia,** L. Common Cat-tail or Reed-mace.
   Ponds and muddy places, not common.

Genus 2. **SPARGANIUM,** Tourn. Burr-reed.

1. **S. eurycarpum,** Englm.
   Ponds and streams, not rare.
2. **S. simplex,** var. **androcladum,** Gray.
   Ponds, rare.

ORDER 89. NAIADACEÆ. PONDWEED FAMILY.

Genus 1. **NAIAS,** L. Naiad.

1. **N. Indica** var. **gracillima,** Braun.
   Deeper ponds.

Genus 2. **POTAMOGETON,** Tourn. Pondweed.

1. **P. natans,** L.
   Deep ponds, common.
2. **P. Claytonii,** Tuckerman.
   Ponds and slow waters, rare.

3. **P. Vaseyi**, Robbins.
   Small pond near Mt. Carmel, Ill.
4. **P. lonchites,** Tuckerman.
   Wabash river, rare,
5. **P. gramineus** var. **spathulæformis,** Gray.
   Wabash river on floating logs.
6. **P. lucens,** L.
   Ponds, rare.
7. **P. pectinatus,** L.
   Wabash river, rare.

ORDER 90. ALISMACEÆ. WATER PLANTAIN FAMILY.

Genus 1. **ALISMA,** L. Water Plantain.

1. **A. Plantago** var. **Americanum,** Gray. **Mad-dog Weed.**
   Muddy wet places, common.

Genus 2. **SAGITTARIA,** L. Arrow-head.

1. **S; variabilis,** Engelm. Common Arrow-head.
   Wet places, common. June, Sept.
2. **S. heterophylla,** Pursh.
   Slow or muddy waters, not rare.
3. **S. graminea,** Michx.
   Muddy waters, rare. June, Sept.

ORDER 91. HYDROCHARIDACEÆ. FROG'S-BIT FAMILY.

Genus 4. **ANACHARIS,** Richard. Water Weed.

1. **A, Canadensis,** Planchon.
   Deep ponds, not common.

ORDER 92. ORCHIDACEÆ. ORCHIS FAMILY.

Genus 1. **HABENARIA,** Willd., R. Br. Rein-orchis.

1, **H. peramœna,** Gray.
   Low moist grounds, not common. June, Aug.

Genus 2. **SPIRANTHES,** Richard. Ladies' Tresses.

1. **S. cernua,** Richard.
   Wet soil rare. Sept., Oct.

Genus 3. **POGONIA,** Juss.

1. **P. pendula,** Lindl.
   Damp rich woods, rare.

Genus 4. **LIPARIS**, Richard. Twayblade.

1. **L. liliifolia**, Richard.
   Shaded rich woods not rare. May, July.

Genus 5. **CORALLORHIZA**, Haller. Coral-root.

1. **C. odontorhiza**, Nutt.
   Shaded woods in rich soil, rare. July, Sept.

Genus 6. **APLECTRUM**, Nutt. Putty-root.

1. **A. hyemale**. Nutt. Adam-and-Eve.
   Rich shaded soil in woods, not common.

Genus 7, **CYPRIPEDIUM**, L. Ladies' Slipper.

1. **C. candidum**, Muhl. Small White Ladies' Slipper.
   Rapidly disappearing, once common here.
2. **C. parviflorum**, Salisb. Smaller Yellow Ladies' Slipper.
   Once common here.

ORDER 93. AMARYLLIDACEÆ. AMARYLLIS FAMILY.

Genus 1. **PANCRATIUM**, L.

1. **P. rotatum**, Ker.
   Moist rich woods and alluvial soil, rare. July, Sept.

Genus 2. **AGAVE**, L. American Aloe.

1. **A. Virginica**, L. False Aloe.
   Dry gravelly or rocky banks, not common. June, Sept.

Genus 3. **HYPOXYS**, L. Star-grass.

1. **H. erecta**, L.
   Rich woods, rare. May, July.

ORDER 94. HÆMODORACEÆ. BLOODWORT FAMILY.

Genus 1. **ALETRIS**, L. Colic-root. Star-grass.

1. **A. farinosa**, L. Unicorn-root. Ague-root. Crow-corn.
   Prairies, almost extinct here.

ORDER 95. IRIDACEÆ. IRIS FAMILY.

Genus 1. **IRIS**, L. Flower-de-Luce.

1. **I. versicolor**, L. Large Blue Flag.
   Wet places, common. May, June.

Genus 2. **PARDANTHUS**, Ker. Blackberry-Lily.

1. **P. Chinensis**, Ker.
   Sandy ridges in bottom lands, not rare. Nat. from China.

Genus 3. **SISYRINCHIUM**, L. Blue-eyed Grass.

1. **S. Bermudiana**, L.
   Open rich woods and moist places, common. April, Aug. Exceedingly variable, passing into var. **anceps, mucronatum**, and **allidum**. All found here.

Order 96. DIOSCOREACEÆ. Yam Family.

Genus 1. **DIOSCOREA**, Plumier. Yam.

1. **D. villosa**, L. Wild Yam-root. Colic-root.
   Bottom lands and thickets, common. June.

Order 97. SMILACEÆ. Smilax Family.

Genus 1. **SMILAX**, Tourn. Greenbrier. Catbrier.

1. **S. rotundifolia**, L Common Greenbrier.
   Moist woods and thickets, common. Variety **quadrangularis**, is also common.
2. **S, glauca**, Walt.
   Upland woods, forming thickets. June. During mild winters leaves hang on and remain green for two or more seasons.
3. **S. herbacea**, L. Carrion Flower.
   Rich grounds, rare. May. Flowers decidedly carrion scented.
4. **S. herbacea**. var. **pulverulenta**, Gray.
   About fields and thickets, not rare. May, June. Flowers scented similar to the staminate flowers of **Ailantus glandulosa.**

Order 98. LILIACEÆ. Lily Family.

Genus 1. **TRILLIUM**, L. Three-leaved Nightshade.

1. **T. sessila**, L.
   Rich woods, rare. April, May. Leaves very slightly blotched.
2. **T. recurvatum**, Beck. Spotted Trillium. Spotted Wake Robin.
   Rich grounds, abundant. April, May. Leaves more plainly spotted than the last.
3. **T. grandiflorum**, Salisb. Large White Trillium or Wake Robin.
   Rich woods, rare. April, May.
4. **T. erectum**, var. **album**, Pursh. Ground Lily. Wake Robin.
   Rich woods, rare. April, May.

Genus 2. **UVULARIA**, L. Bellwort.

1. **U. grandiflora**, Smith.
   Rich hilly woods, not common. April, May.
2. **U. sessiliflora**, L.
   Woods, rare. April, May.

Genus 3. **SMILACINA**, Desf. False Solomon's Seal.

1. **S. racemosa**, Desf. False Spikenard.
   Rich open woods, not rare,
2. **S. stellata**, Desf.
   Shaded banks, not rare. May, June.

Genus 4. **POLYGONATUM**, Tourn. Solomon's Seal.

1. **P. biflorum**, Ell. Smaller Solomon's Seal.
   Shaded woods, not rare.
2. **P. giganteum**, Dietrich. Great Solomon's Seal.
   Rich grounds and thickets, common. May, July.

Genus 5. **ASPARAGUS**, L.

1. **A. officinalis**, L. Garden Asparagus.
   Sparingly escaped from gardens Adv. from Eu.

Genus 6. **LILIUM**, L. Lily.

1. **L. Philadelphicum**, L. Wild Orange-red Lily.
   Low sandy grounds, becoming very rare. July, Aug.
2. **L. Canadense**, L. Wild Yellow Lily.
   Wet prairies, almost disappeared. June, July.
3. **L. superbum**, L. Turk's-cap Lily.
   Low grounds and prairies, rapidly becoming extinct. June, July,

Genus 7. **ERYTHRONIUM**, L. Dog's-tooth Violet.

1. **E. Americanum**, Smith. Yellow Adder's-tongue. Yellow Snowdrop.
   Woods, rare.
2. **E. albidum**, Nutt. White Dog's-tooth Violet. May Pea. Rattlesnake Violet.
   Rich hillsides, not common. March, April.

Genus 8. **ORNITHOGALUM**, Tourn. Star-of-Bethlehem.

1. **O. umbellatum**, L. White Star-of-Bethlehem.
   Escaped from flower gardens. Adv. from Eu.

Genus 9. **SCILLA**, L. Squill.

1. **S. Fraseri**, Gray. Eastern Quamash. Wild Hyacinth.
   Once common on prairies and in woods, now seldom found wild.

Genus 10. **ALLIUM**, L. Onion. Garlic.

1. **A. Canadense**. Kalm. Wild Garlic.
   Prairies and low moist woods. May, June.
2. **A. striatum**, Jacq.
   Prairies, rare.

Genus 11. **HEMEROCALIS**, L. Day Lily.

1. **H. fulva**, L. Common Day Lily.
   Escaped from gardens to sandy fields, rare. Adv. from Eu.
2. **H. flava**, L. Yellow Dog Lily.
   Sparingly escaped from gardens. Adv. from Eu.

ORDER 99. JUNCACEÆ. RUSH FAMILY.

Genus 1. **JUNCUS**, L. Rush. Bog-Rush.

1. **J. marginatus**, Rostkovius.
   Moist prairies and wet places, common.
2. **J. tenuis**, Willd.
   Damp rich soil, common about foot-paths.
3. **J. acuminatus**, Michx.
   Moist places, common.

ORDER 100. PONTEDERIACEÆ. PICKEREL-WEED FAMILY.

Genus 1. **PONTEDERIA**, L. Pickerel-weed.

1. **P. cordata**, L. Blue Pickerel-weed.
   Ponds and muddy places, not rare. June, Sept.

Genus 2. **HETERANTHERA**, Ruiz & Pav. Mud-Plantain.

1. **H. reniformis**, Ruiz & Pav.
   Muddy borders of ponds, rare.

Genus 3. **SCHOLLERA**, Schreber. Water Star-grass.

1. **S. graminea**, Willd.
   Borders of streams, not abundant. July, Sept. Exceedingly variable; when growing in water the leaves and stems are from one to two feet long; while, when found on the muddy borders, they are usually one to two inches in length.

ORDER 101. COMMELYNACEÆ. SPIDERWORT FAMILY.

Genus 1. **COMMELYNA**, Dill. Day Flower.

1. **C. Virginica**, L.
   Rich sandy soil, rare. July, Aug.
2. **C. Cayennensis**, Richard.
   Moist shaded places, common. June, Sept.

Genus 2. **TRADESCANTIA**, L. Spiderwort.

1. **T. Virginica**, L. Common Spiderwort.
   Prairies and rich grounds, common. May, June.
2. **T. pilosa**, Lehm. Tall Spiderwort.
   Thickets and rich grounds, common. June, Aug.

ORDER 102. CYPERACEÆ. SEDGE FAMILY.

Genus 1. **CYPERUS** L.

1. **C. diandrus**, Torr.
   Low grounds, common.
2. **C. crythrorhizos**, Muhl.
   Moist banks of streams, common.
3. **C. phymatodes**, Muhl.
   Muddy borders of streams, not rare.
4. **C. strigosus**, L.
   Damp grounds, abundant.
5. **C. ovularis**, Torr.
   Dry gravelly and sandy soil, common.

Genus 2. **KILLINGIA**, Rottboll.

1. **K. pumila**, Michx.
   Moist rich grounds, common.

Genus 3. **ELEOCHARIS**, R. Br. Spike Rush.

1. **E. obtusa**, Schultes.
   Muddy places, common.
2. **E. tenuis**, Schultes.
   Muddy places.

Genus 4. **SCIRPUS**, L. Bulrush. Club Rush.

1. **S. pungens**, Vahl.
   Muddy borders of streams, not common.
2. **S. validus**, Vahl. Great Bulrush. Lake Rush.
   Ponds and muddy places, rare.
3. **S. atrovirens**, Muhl.
   Wet meadows, common.
4. **S. lineatus**, Mich.
   Wet grounds, common.
5. **S. Eriophorum**, Michx.
   Wet places, common.

Genus 5. **FIMBRISTYLIS**, Vahl.

1. **F. autumnalis**, Rœm. & Schult.
   Moist ground.

Genus 6. **CAREX,** L. Sedge.

1. C. **vulpinoidea,** Michx.
   Common.
2. C. **crus-corvi,** Shuttleworth.
   Not rare.
3. C. **stipata,** Muhl.
   Abundant.
4. C. **cephalophora,** Muhl.
   Common.
5. C. **rosea,** Schk.
   Meadows, common.
6. C. **arida,** Schw. & Torr.
   Fields and meadows, not rare.
7. C. **scoparia,** Schk.
   Fields and wet places, common.
8. C. **fœnea,** Willd.
   Sandy soil, rare.
9. C. **straminea,** Schk.
   Fields and woods, common.
10. C. **Shortiana.** Dew.
    Muddy ponds, rare.
11. C. **tetanica.** Schk.
    Moist borders of ponds and streams. common.
12. C. **conoidea,** Schk.
    Meadows, rare.
13. C. **laxiflora** var. **blanda,** Gray.
    Sandy and shaded places, abundant.
14. C. **intumescens,** Rudge.
    Moist places, abundant.
15. C. **Grayii,** Carey.
    Alluvial soil, common.
16. C. **squarrosa,** L.
    Low grounds.
17. C. **retrorsa,** Schw.
    Wet borders.
18. C. **gigantea,** Rudge.
    Cypress swamp.
19. C. **monile,** Tuckerman.
    Cypress swamp.

Order 103. GRAMINEÆ. Grass Family.

Genus 1. **LEERSIA,** Solander. White Grass.

1. L. **Virginica,** Willd.
   Prairies, not rare.
2. L. **oryzoides,** Swartz.
   Very wet places, not common.

Genus 2. **ZIZANIA,** Gronov. Water or Indian Rice.

1. **Z. aquatica,** L. Indian Rice. Water Oats.
   Shallow ponds, not rare.

Genus 3. **PHLEUM,** L. Cat's tail Grass.

1. **P. pratense,** L. Timothy. Herd's Grass.
   Fields and woods, common. Nat. from Eu.

Genus 4. **SPOROBOLUS,** R. Br. Drop-seed Grass.

1. **S. heterolepis,** Gray.
   Moist prairies, not common.

Genus 5. **AGROSTIS,** L. Bent Grass.

1. **A. scabra,** Willd, Hair Grass.
   Open woods, common.
2. **A. vulgaris,** With. Red Top. Herd's Grass.
   Fields and woods. common. Nat. from Eu.
3. **A. alba,** L. Fiorin or White Bent Grass.
   About fields, common.

Genus 6. **CINNA,** L. Wood Reed Grass.

1. **C. arundinacea,** L.
   Moist prairies, rare.

Genus 7. **MUHLENBERGIA,** Schreber. Drop-seed.

1. **M. Mexicana,** Trin.
   Low grounds, common.

Genus 8. **BRACHYELYTRUM,** Beauv.

1. **B. aristatum,** Beauv.
   Hilly woods, rare.

Genus 9. **ARISTIDA,** L. Triple-awned Grass.

1. **A. ramosissima,** Englm.
   Dry prairies and roadsides, not common.
2. **A. dichotoma,** Michx. Poverty Grass.
   Roadsides and dry gravelly prairies, common.
3. **A. oligantha,** Michx.
   Dry soil, not common.

Genus 10. **DACTYLOCTENIUM,** Willd. Egyptian Grass.

1. **D. Ægyptiacum,** Willd.
   Fields and door yards, not rare. Nat. from Africa?.

Genus 11. **ELEUSINE,** Gærtn. Crab Grass. Yard Grass.

1. **E. Indica,** Gœrtn.
   About dwellings, common. Nat from India?

Genus 12. **TRICUSPIS,** Beauv.

1. **T. seslerioides,** Torr. Tall Red-top.
   Rich grounds and fence rows, common.

Genus 13. **DIARRHENA**, Raf.

1. **D. Americana,** Beauv.
Shaded woods, rare.

Genus 14. **DACTYLIS.** Orchard Grass.

1. **D. glomerata**, L.
About fields, rare. Nat. from Eu.

Genus 15. **KŒLERIA.** Pers.

1. **K. cristata**, Pers.
Along fence-rows in dry, hilly places.

Genus 16. **ETONIA,** Raf.

1. **E. Pennsylvanica**, Gray.
Woods and meadows, common.

Genus 17. **GLYCERIA,** R. Br., Trin. Manna-Grass.

1. **G. fluitans**, R. Br.
Wet places, rare.

Genus 18. **POA,** L. Meadow-Grass. Spear-Grass.

1. **P. pratensis**, L. Kentucky Blue-Grass.
Pastures, fields and door-yards, common.

Genus 19. **ERAGROSTIS**, Beauv.

1. **E. reptans**, Nees.
Prairies and moist places, common.
2. **E. poæoides**, Beauv.
About dwellings and fields, not rare. Nat. from Eu.
3. **E. pilosa**, Beauv.
Gravelly soil, rare. Nat. from Eu.
4. **E. Frankii**, Meyer.
Prairies and open grounds, common.
5. **E. tenuis**, Gray.
Dry soil, not common.
6. **E. pectinacea**, Gray.
Dry soil, not common.

Genus 20. **FESTUCA,** L. Fescue-Grass.

1. **F. elatior**, L. Taller or Meadow Fescue.
Moist prairies, scarce.
2. **F. nutans**, Willd.
Open woods and bluffs.

Genus 21. **BROMUS**, L. Brome-Grass.

1. **B. secalinus**, L. Cheat. Chess.
Fields, fence-rows and borders of woods. Nat. from Eu.
The great enemy of the farmer.
2. **B. racemosus**, L. Upright Chess.
About fields, rare. Nat. from Eu.
3. **B. Kalmii**, Gray. Wild Chess.
Dry open grounds, rare.

Genus 22. **UNIOLA**, L. Spike-Grass. Union-Grass.

1. **U. latifolia**, Michx.
   Shaded moist places, not common.

Genus 23. **PHRAGMITES**, Trin. Reed.

1. **P. communis**, Trin.
   Wet prairies, not rare. Have found specimens 19 feet high.

Genus 24. **ARUNDINARIA**, Michx. Cane.

1. **A. tecta**, Muhl. Small Cane.
   Moist shaded alluvial soil, common.

Genus 25. **HORDEUM**, L. Barley.

1. **H. pratense**, Huds.
   Moist grounds, rare.

Genus 26. **ELYMUS**, L. Lyme-Grass. Wild Rye.

1. **E. Virginicus**, L.
   Shaded banks, common.
2. **E. Canadensis**. L.
   Woods and fields, not rare. June, July.
3. **E. striatus**, Willd.
   Shaded woods, scarce.
4. **E. striatus** var. **villosus**, Gray.
   Rocky bluffs, rare.

Genus 27. **GYMNOSTICHUM**, Schreb. Bottle-brush Grass.

1. **G. Hystrix**, Schreb. Wild Rye.
   Woods and about fields, common. June, Aug.

Genus 28. **PHALARIS**, L. Canary Grass.

1. **P. Canariensis**, L. Canary-seed Grass.
   About dwellings, from seeds scattered from bird cages. June, Sept. Adv. from Eu.
2. **P. arundinacea**, L. Reed Canary Grass.
   Wet shaded places, rare.

Genus 29. **PASPALUM**, L.

1. **P. setaceum**, Michx.
   Sandy places, not rare. Aug., Sept.

Genus 30. **PANICUM**, L. Panic Grass.

1. **P. sanguinale**, L. Common Crab Grass. Finger Grass.
   Too common. Nat from Eu.
2. **P. agrostoides**, Spreng.
   Moist places, rare.
3. **P. capillare**, L. Old-witch Grass.
   Fields and woods, common.
4. **P. virgatum**, L.
   Moist prairies, rare. July, Aug.

5. **P. latifolium**, L.
   Fence-rows and thickets, common.
6. **P. clandestinum**, L.
   Prairies and fence rows, not rare.
7. **P. dichotomum**, L.
   Dry rich grounds, not abundant.
8. . **Crus-galli**, L. Barnyard Grass.
   Moist places in fields and woods. Nat. from Eu.
9. **P. Crus-galli** var. **hispidum**, Gray.
   About fields, rare. Nat. from Eu.

Genus 31. **SETARIA**, Beauv. Bristly Fox-tail Grass.

1. **S. glauca**, Beauv. Fox-tail.
   Abundant, especially in stubble. Nat. from Eu.
2. **S. Italica**, Kunth. Millet. Bengal Grass.
   Escaped from cultivation, rare. Adv. from Eu.

Genus 32. **CENCHRUS**, L. Hedgehog Grass. Bur Grass.

1. **C. tribuloides**, L.
   Sandy soil, not abundant, happily.

Genus 33. **ANDROPOGON**, L. Beard Grass.

1. **A. furcatus**, Muhl. Forked Spike.
   Prairies and fence rows, common.

ORDER 104. EQUISETACEÆ. HORSE-TAIL FAMILY.

Genus 1. **EQUISETUM**, L. Horse-tail.

1. **E. arvense**, L. Common Horse-tail.
   River banks, rare.
2. **E. hyemale**, D. Scouring Rush. Shave Grass.
   Sandy bluffs, common.

ORDER 105. FILICES. FERNS.

Genus 1. **POLYPODIUM**, L. Polypody.

1. **P. incanum**, Swartz.
   On rocky bluffs and trunks of trees, common.

Genus 2. **ADIANTUM**, L. Maiden-hair.

1. **A. pedatum**, L. Maiden-hair Fern.
   Moist shaded places, common.

Genus 3. **PTERIS**, L. Brake. Bracken.

1. **P. aquilina**, L. Common Brake.
   Thickets and woods, rare.

Genus 4. **CHEILANTHES**, Swartz. Lip Fern.

1. **C. vestita**, Swartz.
   Rocky bluffs, rare.

Genus 5. **PELLÆA**, Link. Cliff-Brake.

1. **P. atropurpurea**, Link.
   Rocky cliffs, rare.

Genus 6. **ASPLENIUM**, L. Spleenwort.

1. **A. pinnatifidum**, Nutt.
   Rocky bluffs, rare.
2. **A. Trichomanes**, L.
   Shaded hillsides, not rare.
3. **A. ebeneum**, Ait.
   Rocky banks and bluffs, common.
4. **A. angustifolium**, Michx.
   Rich shaded woods, common.
5. **A. thelypteroides**, Michx.
   Rich woods, common.
6. **A. Filix-fœmina**, Bernh.
   Moist woods, rare.

Genus 7. **CAMPTOSORUS**, Link. Walking-Leaf.

1. **C. rhizophyllus**, Link.
   Rocky bluffs and cliffs, not rare.

Genus 8. **PHEGOPTERIS**, Fee. Beech-Fern.

1. **P. hexagonoptera**, Fee.
   Woods, very common.

Genus 9. **ASPIDIUM**, Swartz. Shield-Fern. Wood-Fern.

1. **A. Thelypteris**, Swartz.
   Wet places, common.
2. **A. Noveboracense**, Swartz.
   Moist places, not rare.
3. **A. acrostichoides**, Swartz.
   Woods and hillsides, abundant. Fronds often remain green all winter.

Genus 10. **CYSTOPTERIS**, Bernh. Bladder-Fern.

1. **C. fragilis**, Bernh.
   Shaded rocky cliffs, common.

Genus 11. **ONOCLEA**, L. Sensitive Fern.

1. **O. sensibilis**, L.
   Moist rich places and thickets, common.

Genus 12. **WOODSIA**, R. Brown.

1. **W. obtusa**, Torr.
   Rocky banks, rare.

Genus 13. **DICKSONIA**, L'Her.

1. **D. punctilobula**, Kunze.
   Moist places, rare.

Genus 14. **OSMUNDA.** Flowering Fern.

1. **O. regalis**, L. Flowering Fern.
   Moist places, not common.
2. **O. Claytoniana**, L. Interrupted Fern.
   Shaded steep banks, rare.

Genus 15. **BOTRYCHIUM,** Swartz. Moonwort.

1. **B. Virginicum,** Swartz. Rattle-snake Fern.
   Shaded woods, scarce.
2. **B. lunarioides**, Swartz.
   Rich woods, rare.

Genus 16. **OPHIOGLOSSUM,** L. Adder's-Tongue.

1. **O. vulgatum,** L.
   Moist woods, very rare.

Order 106. LYCOPODIACEÆ. Club-Moss Family.

Genus 1. **SELAGINELLA**, Beauv.

1. **S. rupestris**, Spring.
   Dry rocky places, rare.
2. **S. apus**, Spring.
   Moist shaded places, rare.

Order 107. CHARACEÆ. Chara Family.

Genus 1. **CHARA**.

1. **C. polyphylla**.
   In Wabash river, rare.

INDEX AND SYNOPSIS

OF THE

BOTANY OF LOWER WABASH.

107 orders; 444 genera; 867 species.

INDEX.

ERRATA.

Page 14, line 17, for "wash coal" read "rash coal."
" 37, " 15, for "grains" read "grams."
" 37, " 16, for "grains" read "grams."
" 148, " 5, for "00 ft." read "45 ft."
" 152, " 14, for "shaley" read "clay."
" 154, bottom line, for "T. S." read "L. S."
" 157, line 16, for "t" read "at."
" 209, " 18, for "strata" read "stratum."
" 212, " 22, for "strata" read "stratum."
" 212, bottom line, for "this" read "the."
" 216, line 13, substitute a period for the comma after "*Producti*."
" 216, " 14, substitute a comma for the period after "*proliferum*;" for "Fossils" read "fossils," and insert a comma after "group.."
" 217, " 12, for "Gordoni" read "Godoni."
" 222, " 34, omit "that."
" 223, " 10, for "diameter" read "circumference."
" 223, " 20, for "or" read "and."
" 225, " 34, for "French Lick" read "Lick creek."
" 231, " 23, insert "few" before "feet."
" 251, " 26, for "slabs" read "shales."
" 252, " 22, for "alluvial" read "Anvil."
" 252, " 24, for "alluvial" read "animal."
" 252, " 43, for "Best" read "Bituminous."
" 257, " 4, for "*Stegocephalus*" read "*Stegocephalous*."
" 257, " 28, for "*Cricodus heterolites*" read "*Cricotus heteroclitus*."
" 257, " 29, for "*basilatus*,' read "*Vinslovii*."
" 258, " 2, for "*Criassic*" read "*Triassic*."
" 259, " 37, for "occurs" read "occur."
" 261, " 17, for "*carbonarius*;" read "*carbonaria*."
" 261, " 23, for "white" read "while."
" 263, " 8, erase comma after "pound" and insert it after "succeeding."
" 264, " 20, for "course" read "coarse."
" 268, " 9, erase "as."
" 270, " 36, for "Paludinum" read "Paludina."

Page 272, " 35, erase comma and insert "limestone" after "Conglomerate."
" 276, " 14, for "of" read "at."
" 288, " 35, erase "and also."
" 297, " 8, insert comma after "late" and remove the dash after "early."
" 300, " 32, for "Lead" read "Reed."
" 301, " 21, for "takes rise" read "enters."
" 308, " 18, after "the" insert "Glacial age."
" 315, " 10, for "Stiltz" read "Stultz."
" 315, " 35, for "last of" read "at."
" 316, " 15, insert "of" after "is."
" 316, last line, erase period and insert comma.
" 317, line 14, for "as" read "at."
" 325, " 2, erase period and insert comma.
" 331, " 7, for "from the" read "to."
" 331, " 8, for "upon" read "up on."
" 331, " 36, for "Plant" read "A few plant."
" 342, " 19, erase "bright."
" 348, " 38, for "A. Grim" read "H. Grim."
" 363, " 29, insert "soil" after "A clay."
" 363, " 34, for "mutual" read "mental."
" 365, " 6, for "then" read "there."
" 368, " 10, after "until" insert "from."
" 375, " 25, for "insects" read "animals."
" 376, " 30, for "*Chrondrites*" read "*Chondrites*."
" 377, " under "Genus Batocrinus" add "*B. Indianensis*" and "*B. biturbinatus*."
" 388, " 14, for "E. H. Corey', read "L. H. Corey."
" 401, " 15, erase "as."
" 401, " 31, for "crevices" read "cavities."
" 410, " 14, for "compact" read "composed."
" 411, " 30, for "stone" read "store."
" 414, " 20, for "'eastern" read "western."
" 425, " 18, for "barely" read "bravely."
" 426, " 14, for "stated" read "stand."
" 435, last line, for "coal I" read "coal J."
" 441, line 4, for "two feet eight" read "three feet eight."
" 451, " 18, for "Adontopteris" read "Odontopteris."
" 463, " 7, for "but" read "therefore."
" 521, Order 16, for "MALOACEÆ" read "MALVACEÆ."
" 524, line 19, for "Haliacabum" read "Halicacabum."
" 525, " 8, for "violacens" read "violaceus."
" 525, " 11, for "fructicosa" read "fruticosa."